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Studies on the Genus *Grimmia*, with Reference to the Affinity of Gametophyte*

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I. Introduction and Acknowledgements

The universally accepted classification of the Grimmiaceae is that of BROTHERUS (1924) in ENGLER-PRANTL's Pflanzenfamilien. His treatment, summarized in Table 1, is based on the features of both gametophyte and sporophyte.

Table 1. Summary of the classification of Grimmiaceae (BROTHERUS 1924).

I. Subfam. **Scoulerioideae**

Blattrippe mit mehreren medianen Deutern. Kapsel ohne Luftraum.

1. *Scouleria* HOOK.

II. Subfam. **Grimmioideae**

Blattrippe mit ventralen Deutern oder homogen. Kapsel meist mit Luftraum.

2. *Coscinodon* SPRENG.
3. *Indusiella* BROTH. et C. MUELL.
4. *Aligrimmia* WILLIAMS
5. *Grimmia* EHRH.
6. *Rhacomitrium* BRID.

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Before then, DIXON (1896) divided British mosses of Grimmiaceae into seven genera. LOESKE (1930) divided this family, with respect to the European species, into five genera. GROUT (1933) divided this family of North America into four subfamilies and eight genera: Subfam. I. Grimmieae (*Glyphomitrium*, *Grimmia*), Subfam. II. Scoulerieae (*Scouleria*), Subfam. III. Hedwigieae (*Braunia*, *Hedwigia*), Subfam. IV. Ptychomitrieae (*Campylostelium*, *Ptychomitrium*, *Rhacomitrium*). NYHOLM (1956) divided the family of Fennoscandia into four genera. The classification of the Grimmiaceae has thus been made differently by each scholar (Table 2). *Glyphomitrium*, *Hedwigia*, *Braunia*, *Campylostelium* and *Ptychomitrium* were included in Grimmiaceae by DIXON and GROUT, but most of the modern bryologists, following BROTHERUS (1924), treat them as members of other families.

Table 2. Genera adopted in principal classification systems of Grimmiaceae.

DIXON (1896)	BROTHERUS (1924)	LOESKE (1930)	GROUT (1933)	NYHOLM (1956)
Glyphomitrium			*Glyphomitrium*	
Coscinodon	*Coscinodon*	*Coscinodon*		*Coscinodon*
Grimmia	*Grimmia*	*Schistidium* *Hydrogrimmia* *Grimmia* *Dryptodon*	*Grimmia*	*Schistidium* *Grimmia*
Rhacomitrium	*Rhacomitrium*	*Rhacomitrium*	*Rhacomitrium*	*Rhacomitrium*
	Scouleria		*Scouleria*	
	Indusiella			
	Aligrimmia			
Hedwigia			*Hedwigia*	
			Braunia	
Campylostelium			*Campylostelium*	
Ptychomitrium			*Ptychomitrium*	

Even one genus of the Grimmiaceae, *Grimmia*, is submitted to different ways of classification. That is, *Grimmia* was divided by DIXON into three sections: *Schistidium*, *Gasterogrimmia*, *Eugrimmia*. His classification of the sections is based on the features of sporophyte (seta, capsule, columella). BROTHERUS divided this genus into seven subgenera including *Litoneurum*, *Gümbelia*, *Hydrogrimmia*, *Rhabdogrimmia*, *Schistidium*, *Gastrogrimmia* and *Streptocolea*, based on the features of both gametophyte (leaves, midrib) and sporophyte (seta, capsule, columella). In LOESKE's system, which was based on the characteristics of both gametophyte (leaves, midrib) and sporophyte (seta, columella), the genus *Grimmia* in BROTHERUS's sense was divided into four genera: *Schistidium*, *Hydrogrimmia*, *Grimmia*, *Dryptodon*, and his *Grimmia* sens. str. has seven sections: *Litoneurum*, *Alpestres*, *Alpinae*, *Torquatae*, *Rhabdogrimmia*, *Pulvinatae* and *Gastrogrimmia*. GROUT divided *Grimmia* into three subgenera: *Schistidium*, *Coscinodon*, *Eugrimmia*, the last being further divided into eight subsections: *Hydrogrimmia*, *Gasterogrimmia*, *Litoneurum*, *Alpestres*, *Alpinae*, *Pulvinatae*, *Torquatae*, *Trichophyllae* and his classification relies on the features of both gametophyte (leaves, leaf-cells, calyptra) and sporophyte (seta, capsule, columella). In the present study, I follow BROTHERUS' concept.

The taxonomical study of *Grimmia* has to be made from more than one point of view. In this dissertation, however, I place my primary emphasis upon the characteristics of the gametophyte. As it is not always easy to find sporophytes in *Grimmia* species, the features of the gametophyte are more useful than those of the sporophyte in the taxonomy of this genus. The inner structure of the gametophyte has several characteristics which are peculiar to the species, but it has so far been little investigated. This is the very reason why I focus my attention on the observation of the gametophytic characteristics.

I study the inner structure of the stem and the leaf, into which the gametophyte is differentiated. As is generally the case with Bryidae, the stem consists of the epidermal layer, cortical layer and central strand, but the observation of the cross section of the stem reveals that the distinctions among these three are not always clear. In species like *Grimmia alpicola*, the three parts of the stem are almost indistinguishable; in others, the differences are quite distinct, and in some of them (*Grimmia arizonae*, *Gr. robusta*) the central strand is fully developed.

In studying the inner structure of the leaf, the midrib seems to be the most important of all the parts of the leaf. I start this observation of the midrib with tracing the mode of ontogeny. The first midrib tissue to appear is the part which connects with the cells of the lamina, that is, adaxial part, and this I name **a-part**. Next I name **c-part** the layer of cells which is formed on the abaxial side of the **a-part** through its cell divisions. Lastly I name **b-part** the cell group which is formed inside the **c-part** through its cell divisions (Fig 1). I trace the change in cell-number of the three parts in the series of cross sections made along the midrib from young leaves of the stem-apex to older ones of the stem-base and regard it as reflecting the ontogenetic process of the midrib. The study shows that the mode of ontogeny of the midrib is characteristic to the species.

Next I observe the structure of the completed midrib, which might be considered in two ways, numerically and morphologically. The number of the cells of the **a-part** is found to be definitely specific. This specificity of the number of cells of the adaxial layer of the midrib corresponds to the specificity of the number of the cells of the ventral side surface of the midrib in gametophyte of some Hepaticae such as *Metzgeria*. In some species (*Grimmia incurva*, *Gr. apocarpa* var. *atrofusca*, *Gr.*

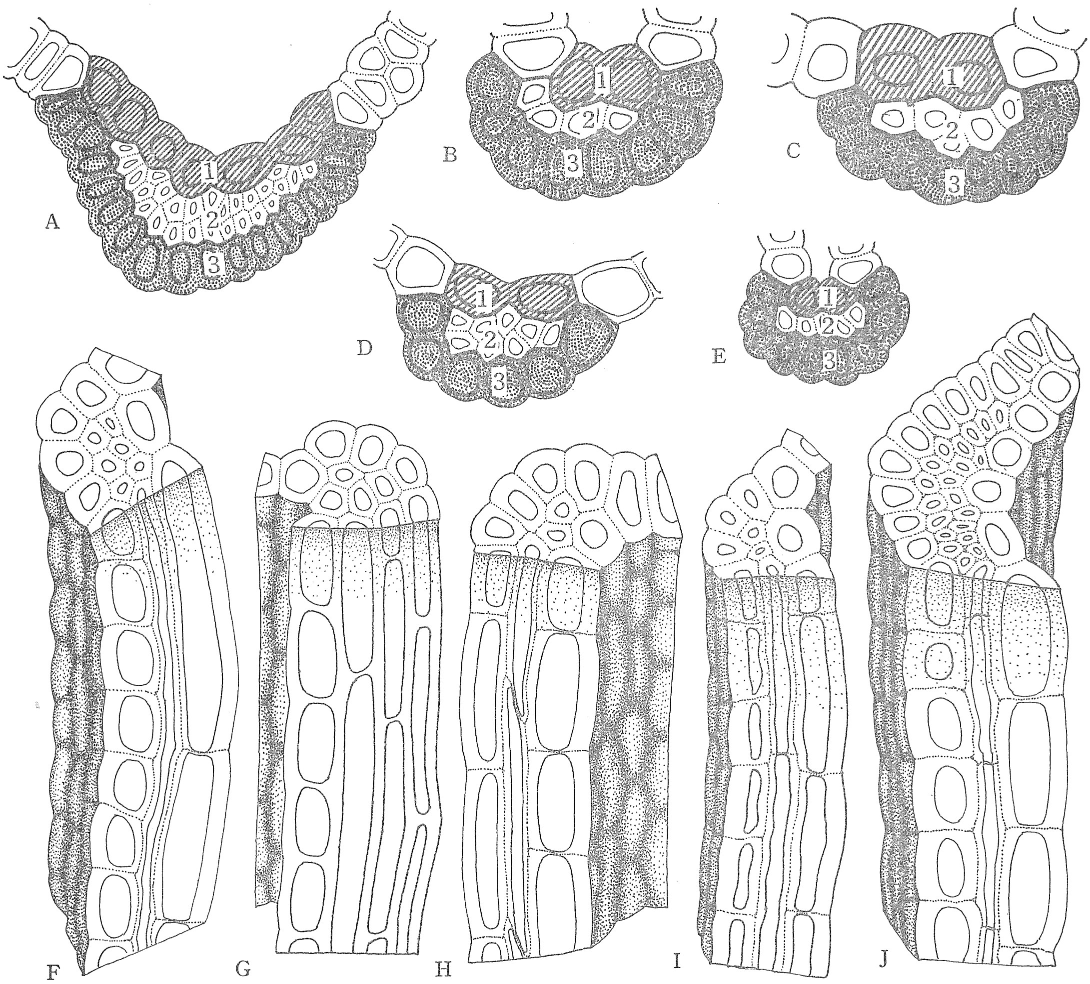

Fig. 1. Cross and longitudinal sections of the midrib.
A–E : Cross sections of the midrib, F–J : longitudinal sections of the midrib. A : *Gr. ovalis* (HEDW.) LINDB., B : *Gr. donniana* SM. (1), C : *Gr. gracilis* SCHWAEGR., D : *Gr. pulvinata* (HEDW.) SM., E : *Gr. donniana* SM. (2), F: *Gr. pulvinata* (HEDW.) SM., G : *Gr. donniana* SM. (1), H: *Gr. gracilis* SCHWAEGR., I: *Gr. donniana* SM. (2), J: *Gr. ovalis* (HEDW.) LINDB., 1: **a-part** (the hatched part), 2: **b-part** (the blank part), 3: **c-part** (the dotted part).

gracilis f. *subepilosa*) the three parts, **a-part**, **b-part** and **c-part** look quite indistinguishable morphologically; in others, however, these are quite distinct in the cross section; further, among these some (*Gr. maritima*) even have guide cells in the **b-part**. Thus several characteristics of the inner structure of the gametophyte are specific to the species and the degree of differentiation in the ontogeny is different from species to species. Seeing that affinity regarding such structural characteristics is definitely present, I conclude that these characteristics have to be given due emphasis in taxonomical studies.

As for the external structure of the leaf, I examine the shape of the leaf and whether a hyaline point is present or not at the end of the leaf; when present whether the hyaline point is indented or not; whether the leaf margin is one or two cells thick; whether, in the latter case, the upper half alone or the base as well is two cells thick; whether the leaf apex is dull or sharp, indented or not. The form of the leaf-cell taken from the apex, middle or the base of the leaf shows distinct characteristics which are peculiar to the species. Placing emphasis on these points, fourty-one species of *Grimmia* are examined and their taxonomical interrelations are studied in the present work.

I extend my cordial thanks to Dr. Y. HORIKAWA, Professor of Hiroshima University, for constant guidance and encouragement throughout the work. I also should like to express my thanks to Dr. G. MASAMUNE, Professor of Kanazawa University, for his kind advice. I am indebted to Dr. H. SUZUKI and Dr. H. ANDO of Hiroshima University who have given me several useful suggestions. I am further deeply obliged to Dr. S. HATTORI, Director of Hattori Botanical Laboratory, Dr. N. TAKAKI of Nagoya University and Dr. H. OCHI of Tottori University who have assisted me by forwarding *Grimmia* specimens to be studied.

II. Material and Methods

Material used for the present study comprises specimens of *Grimmia* collected from Japan, U.S.A., Switzerland, Korea, Finland, Czechoslovakia, Canada, England, Mexico, Sweden, Denmark, Spain, Austria and some other countries. All the samples observed are depsited in the Herbarium of the Botanical Institute, Kanazawa University.

*acutifolia**	:	*Gr. apocarpa* var. *rivularis* f. *acutifolia* (T. JENS.) ; U. S. A. (10543).
africana	:	*Gr. pulvinata* var. *africana* (HEDW.) HOOK. f. et WILS. ; France (10566, 10567), Czechoslovakia (10539).
agassizii	:	*Gr. agassizii* (SULL. et LESQ.) JAEG. ; Finland (10545), Czechoslovakia (10582).
alpicola	:	*Gr. alpicola* HEDW. ; Canada (10643), U. S. A. (10524, 10595, 10639).
anodon	:	*Gr. anodon* B. S. G. ; Bohemia (10553), Czechoslovakia (10526).
anomala	:	*Gr. anomala* HAMPE ; Canada (10562).
apocarpa	:	*Gr. apocarpa* HEDW. ; Bohemia (10482), Canada (10649, 10651), Denmark (10683), England (10470), Japan (10480, 10511, 10513) Mexico (10650), Sweden (10484), U. S. A. (10483, 10492).
arizonae	:	*Gr. arizonae* REN. et CARD. ; U. S. A. (10549).
atrofusca	:	*Gr. apocarpa* var. *atrofusca* (SCHIMP.) HUSN. ; Czechoslovakia (10575).
calvescens	:	*Gr. funalis* var. *calvescens* (KINDB.) MOELL. ; Bohemia (10591), Finland (10548), Czechoslovakia (10535).
conferta	:	*Gr. apocarpa* var. *conferta* (FUNCK) SPRENG. ; Finland (10546).
cratericola	:	*Gr. cratericola* SAK. et TAK. ; Japan (10540).

decalvata : *Gr. decalvata* CARD. ; Japan (10632, 10644).
decipiens : *Gr. decipiens* (SCHULTZ.) LINDB. ; England (10593), Spain (10517), Sweden (10628, 10693).
donniana : *Gr. donniana* SM. ; France (10499), Japan (10501, 10616), Korea (10455), Switzerland (10621, 10672), U. S. A. (10476, 10500, 10620).
elatior : *Gr. elatior* BRUCH ; Austria (10602, 10689), Finland (10471, 10523, 10574), Japan (10460, 10472, 10641), Czechoslovakia (10518).
epilosa : *Gr. brunnescens* f. *epilosa* (SCHIFFN.). PAR. ; Bohemia (10561), Czechoslovakia (10529).
funalis : *Gr. funalis* (SCHWAEGR.) B. S. G. ; Finland (10629, 10673), Czechoslovakia (10519).
gracilis : *Gr. gracilis* SCHWAEGR. ; Alaska (10585), Finland (10642, 10691), Japan (10514).
hartmanii : *Gr. hartmanii* SCHIMP. ; Austria (10490), Soviet (10487), Sweden (10486, 10488).
humilior : *Gr. brunnescens* f. *humilior* VILHL.; Czechoslovakia (10530).
incurva : *Gr. incurva* SCHWAEGR. ; Japan (10550).
laevigata : *Gr. laevigata* (BRID.) BRID. ; Czechoslovakia (10581), U. S. A. (10544, 10617).
lisae : *Gr. trichophylla* ssp. *lisae* (DE NOT.) BOUL. ; Spain (10532, 10538).
longipila : *Gr. funalis* f. *longipila* BOUL. ; Czechoslovakia (10520).
maritima : *Gr. maritima* TURN. ; U. S. A. (10601, 10626, 10695).
microtheca : *Gr. apocarpa* var. *microtheca* CARD. ; Japan (10633).
mollis : *Gr. mollis* B. S. G. ; Czechoslovakia (10684), U. S. A. (10634).
ovalis : *Gr. ovalis* (HEDW.) LINDB. ; Alaska (10659), Bohemia (10570), Canada (10568), Finland (10666), France (10515), Guatemala (10664), Himalaya (10786), India (10663), Czechoslovakia (10660, 10662), Spain (10522, 10569), Sweden (10571).
patens : *Gr. patens* (HEDW.) B. S. G. ; England (10606), Norway (10605), Czechoslovakia (10558). U. S. A. (10537).
persica : *Gr. orbicularis* var. *persica* SCHIFFNER ; Austria (10536).
pilifera : *Gr. pilifera* P. BEAUV. ; Japan (10507, 10510), U. S. A. (10509).
plagiopodia : *Gr. plagiopodia* HEDW. ; Czechoslovakia (10557), U. S. A. (10533).
pulvinata : *Gr. pulvinata* (HEDW.) SM. ; Denmark (10495), U. S. A. (10497).
rivularis : *Gr. apocarpa* var. *rivularis* (BRID.) NEES et HORNSCH. ; Bohemia (10610), Canada (10676), England (10678), France (10675), Czechoslovakia (10681), U. S. A. (10680).
robusta : *Gr. trichophylla* f. *robusta* PODP. ; Spain (10534).
subepilosa : *Gr. gracilis* f. *subepilosa* PILOUS ; Czechoslovakia (10577).
tenerrima : *Gr. apocarpa* var. *tenerrima* NEES et HORNSCH. ; Finland (10541).
tenuis : *Gr. gracilis* f. *tenuis* VILHL. ; Bohemia (10528).
teretinervis : *Gr. teretinervis* LIMPR. ; Czechoslovakia (10576).
torquata : *Gr. torquata* GREV. ; Canada (10623), Finland (10697), Czechoslovakia (10590).

For anatomical studies, microtome sections are prepared by the ethylalchol-butyl alcohol-paraffin method, following BOUIN's fluid fixation. The inner stucture of the stem and leaf is studied from serial transverse and longitudinal sections having a

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* Epithets in the head column are used in later synthetic tables as abbreviation for each specific name.

thickness of ten microns, as well as from material cleared in methyl salycilate or lactophenol. DELAFIELD's haematoxylin or methyl green and acid fuchsin combinations are used for staining anatomical preparations.

III. Morphological Observation of Gametophyte

The gametophyte of the *Grimmia* differentiates itself into a stem and leaves which are attached to the stem in three rows. The leaf has a midrib at the middle which reaches up to the apex of the leaf. The lamina is symmetrical with the midrib at the center. It is mostly egg- or lance-shaped. Its cells have very thick membranes except for a few species.

1. Inner Structure of the Midrib

All the species of *Grimmia* have a midrib, which extends to the apex of the leaf. When the midrib is observed in its cross section, the number, alignment and morphology of the cells are known to be different from species to species. Such a differentiation of inner structures is also traced from the base to the apex in the same leaf. Furthermore there are differences between the old leaves and the young ones. Variation in the same species is also known to exist. These facts make it very difficult to determine the representative structure of the midrib of a species. However, the degree of variation is not so great as to obscure the specificity of a species. In this study I make my observation on the following respects : (1) ontogenetic process of the midrib ; (2) structure of the midrib in final development.

(1) Observation of the Ontogeny of Midrib

As stated before, considering the progress of the ontogeny, the structure of midrib tissue is divided into three parts: **a-**, **b-**, and **c-part**. Putting together the number of cells of each part, I get the formula $\mathbf{a+b+c=T}$ (**a**, **b**, **c**, the number of the cells of the **a-**, **b-**, **c-part**; **T**, the total number of the cells). The structure at the primary stage of the ontogeny of midrib is represented as follows: $\mathbf{1a+0b+0c=1}$, $\mathbf{2a+0b+0c=2}$, etc., which show that the **a-part** is formed first of all. At the next stage the **c-part** is produced, which fact is shown in formulae: $\mathbf{2a+0b+1c=3}$, $\mathbf{2a+0b+2c=4}$, $\mathbf{2a+0b+3c=5}$, $\mathbf{2a+0b+4c=6}$, etc. At the final stage, the **b-part** come out of the **c-part** as shown in formulae : $\mathbf{2a+1b+4c=7}$, $\mathbf{2a+2b+4c=8}$, etc. Thus by observing a large number of individuals, I determine serial stages of the ontogeny of midrib and at the same time obtain the final completed structure. In some species, however, even this method fails to give a clear-cut picture of the ontogeny. Next I give some examples of the ontogeny of midrib.

Table 3. Frequency of observation of each stage in the ontogeny of midrib of *Gr. apocarpa* var. *rivularis* f. *acutifolia* (T. JENS.).

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+1b+4c	8	16=4a+7b+5c	4	25=5a+12b+8c	3
=3a+0b+4c	1	=5a+4b+7c	1	=4a+12b+9c	6
8=2a+2b+4c	5	17=3a+7b+7c	4	26=4a+14b+8c	1
9=2a+3b+4c	6	=3a+8b+6c	7	=4a+12b+10c	10
10=2a+3b+5c	9	=4a+8b+5c	10	=5a+13b+8c	7
=2a+4b+4c	8	18=3a+8b+7c	6	=6a+12b+8c	1
=3a+3b+4c	5	=4a+8b+6c	5	=7a+8b+11c	1
11=2a+3b+6c	6	=4a+6b+8c	1	=6a+10b+10c	1
=2a+4b+5c	10	19=3a+9b+7c	6	27=4a+12b+11c	4
=3a+3b+5c	7	=4a+8b+7c	10	=5a+13b+9c	5
=3a+4b+4c	4	=5a+7b+7c	1	=7a+10b+10c	1
12=2a+4b+6c	7	=5a+8b+6c	1	=8a+9b+10c	1
=2a+5b+5c	10	20=3a+10b+7c	10	28=4a+13b+11c	10
=3a+4b+5c	6	=4a+8b+8c	6	=5a+14b+9c	6
=4a+3b+5c	3	=5a+6b+9c	1	=6a+12b+10c	1
13=2a+5b+6c	8	=5a+7b+8c	1	=7a+11b+10c	1
=2a+6b+5c	5	21=4a+11b+6c	1	29=4a+14b+11c	5
=3a+4b+6c	6	=4a+10b+7c	6	=5a+14b+10c	8
=3a+6b+4c	1	=5a+8b+8c	10	=5a+12b+10c	1
=4a+3b+6c	1	=5a+7b+9c	1	=6a+12b+11c	1
=4a+4b+5c	8	=5a+9b+7c	1	=6a+13b+10c	1
14=2a+7b+5c	5	=6a+8b+7c	1	30=4a+15b+11c	9
=3a+5b+6c	6	=6a+7b+8c	1	=5a+15b+10c	6
=4a+4b+6c	1	22=4a+10b+8c	7	=5a+14b+11c	5
=5a+3b+6c	1	=5a+9b+8c	4	=6a+15b+9c	1
=5a+4b+5c	1	=6a+8b+8c	1	=7a+13b+10c	1
=4a+5b+5c	9	23=4a+11b+8c	7	31=4a+16b+11c	8
15=2a+8b+5c	8	=5a+10b+8c	10	=5a+15b+11c	8
=3a+6b+6c	5	=6a+9b+8c	1	32=4a+16b+12c	5
=4a+5b+6c	1	24=4a+11b+9c	6	=5a+16b+11c	6
=5a+4b+6c	1	=5a+11b+8c	3	33=5a+16b+12c	9
=4a+6b+5c	6	=6a+8b+10c	1	34=5a+17b+12c	8
16=3a+7b+6c	10	=6a+9b+9c	1	35=5a+18b+12c	5
=3a+8b+5c	7	=7a+8b+9c	1		

Table 4. Frequency of observation of each stage in the ontogeny of midrib of *Gr. funalis* var. *calvescens* (KINDB.) MOELL.

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+0b+5c	10	10=2a+1b+7c	5	11=3a+0b+8c	10
=2a+1b+4c	7	=2a+2b+6c	6	=3a+1b+7c	7
8=2a+0b+6c	4	=2a+3b+5c	1	=3a+2b+6c	10
=2a+1b+5c	7	=3a+0b+7c	9	12=3a+1b+8c	6
=3a+0b+5c	10	=3a+1b+6c	8	=3a+2b+7c	5
9=2a+0b+7c	6	11=2a+1b+8c	5	=4a+0b+8c	8
=2a+1b+6c	3	=2a+2b+7c	6	=4a+1b+7c	9
=3a+0b+6c	8	=2a+3b+6c	1	13=4a+0b+9c	6

13=4a+1b+8c	5	14=5a+0b+9c	3	17=4a+2b+11c	6
=3a+1b+9c	5	15=4a+1b+10c	6	=5a+2b+10c	9
=3a+2b+8c	4	=4a+2b+9c	10	=5a+3b+9c	1
14=3a+1b+10c	7	=5a+0b+10c	7	=6a+1b+10c	1
=3a+2b+9c	4	16=4a+4b+8c	1	=6a+0b+11c	1
=3a+3b+8c	1	=4a+2b+10c	4	18=5a+3b+10c	1
=4a+0b+10c	6	=5a+1b+10c	7	=5a+2b+11c	9
=4a+1b+9c	3	=5a+2b+9c	5	19=5a+2b+12c	5

Table 5. Frequency of observation of each stage in the ontogeny of midrib of *Gr. agassizii* (SULL. et LESQ.) JAEG.

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+2b+3c	5	15=2a+8b+5c	5	20=2a+12b+6c	9
8=2a+2b+4c	6	16=2a+7b+7c	7	21=2a+10b+9c	6
=2a+3b+3c	10	=2a+8b+6c	4	=2a+11b+8c	10
9=2a+3b+4c	7	=2a+5b+9c	1	=2a+12b+7c	7
10=2a+4b+4c	4	17=2a+7b+8c	6	=2a+13b+6c	4
11=2a+4b+5c	6	=2a+8b+7c	3	22=2a+11b+9c	6
=2a+5b+4c	3	=2a+9b+6c	6	=2a+12b+8c	6
12=2a+5b+5c	6	=2a+10b+5c	1	=2a+13b+7c	4
=2a+6b+4c	4	18=2a+8b+8c	6	=3a+12b+7c	1
=2a+3b+6c	1	=2a+9b+7c	10	23=2a+12b+9c	7
13=2a+5b+6c	7	=2a+10b+6c	7	=2a+13b+8c	5
=2a+6b+5c	5	=2a+11b+5c	1	=2a+14b+7c	9
=2a+7b+4c	9	19=2a+9b+8c	4	=3a+11b+9c	1
14=2a+6b+6c	6	=2a+10b+7c	7	24=2a+14b+8c	6
=2a+7b+5c	10	=2a+11b+6c	10	=2a+13b+9c	5
=2a+8b+4c	5	20=2a+9b+9c	6	=3a+13b+8c	1
15=2a+6b+7c	6	=2a+10b+8c	5		
=2a+7b+6c	9	=2a+11b+7c	8		

Table 6. Frequency of observation of each stage in the ontogeny of midrib of *Gr. anomala* HAMPE.

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+0b+5c	5	14=2a+3b+9c	7	19=2a+6b+11c	6
8=2a+0b+6c	8	=2a+4b+8c	9	=2a+8b+9c	7
9=2a+0b+7c	7	15=2a+3b+10c	4	20=2a+6b+12c	8
=2a+1b+6c	3	=2a+4b+9c	6	=2a+8b+10c	5
10=2a+0b+8c	9	16=2a+4b+10c	8	21=2a+7b+12c	4
=2a+1b+7c	6	=2a+5b+9c	12	=2a+8b+11c	7
=2a+2b+6c	6	=2a+6b+8c	1	=3a+7b+11c	1
11=2a+1b+8c	4	17=2a+5b+10c	7	22=2a+8b+12c	7
=2a+2b+7c	7	=2a+6b+9c	7	=2a+9b+11c	4
12=2a+2b+8c	8	=2a+7b+8c	1	=2a+10b+10c	1
=2a+3b+7c	11	=2a+8b+7c	1	23=2a+9b+12c	8
13=2a+2b+9c	5	18=2a+5b+11c	4	=2a+10b+11c	6
=2a+3b+8c	8	=2a+7b+9c	9	=3a+9b+11c	1

=3a+10b+10c	1	30=2a+15b+13c	7	35=5a+14b+16c	1
24=2a+9b+13c	8	31=2a+13b+16c	7	36=2a+17b+17c	7
=2a+10b+12c	4	=2a+14b+15c	8	=2a+18b+16c	5
=2a+11b+11c	7	=2a+15b+14c	6	=2a+19b+15c	4
25=2a+9b+14c	6	=2a+16b+13c	9	=2a+20b+14c	1
=2a+10b+13c	6	32=2a+14b+16c	4	37=2a+17b+18c	7
=2a+11b+12c	9	=2a+15b+15c	7	=2a+18b+17c	6
=2a+12b+11c	4	=2a+16b+14c	7	=2a+19b+16c	9
26=2a+10b+14c	10	=2a+17b+13c	9	=2a+20b+15c	1
=2a+11b+13c	6	33=2a+14b+17c	5	38=2a+18b+18c	7
=2a+12b+12c	5	=2a+15b+16c	6	=2a+19b+17c	8
27=2a+11b+14c	9	=2a+16b+15c	10	=2a+20b+16c	6
=2a+12b+13c	7	=2a+17b+14c	9	39=2a+19b+18c	10
28=2a+11b+15c	7	34=2a+15b+17c	7	=2a+20b+17c	7
=2a+12b+14c	4	=2a+16b+16c	8	40=2a+20b+18c	7
=2a+13b+13c	9	=2a+17b+15c	10	=2a+21b+17c	9
=2a+10b+16c	1	=2a+18b+14c	7	41=2a+21b+18c	8
29=2a+11b+16c	8	=2a+19b+13c	1	42=2a+22b+18c	5
=2a+12b+15c	6	35=2a+14b+19c	1	43=2a+23b+18c	6
=2a+13b+14c	10	=2a+15b+18c	1	44=2a+24b+18c	11
=2a+14b+13c	7	=2a+16b+17c	4	45=2a+25b+18c	7
=4a+11b+14c	1	=2a+17b+16c	5	46=2a+26b+18c	13
30=2a+12b+16c	10	=2a+18b+15c	7	47=2a+27b+18c	5
=2a+13b+15c	6	=2a+19b+14c	1	48=2a+28b+18c	9
=2a+14b+14c	9	=2a+20b+13c	1		

Table 7. Frequency of observation of each stage in the ontogeny of midrib of *Gr. trichophylla* f. *robusta* PODP.

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+0b+5c	7	27=6a+7b+14c	1	37=6a+16b+15c	6
8=2a+0b+6c	9	28=4a+11b+13c	7	38=5a+17b+16c	6
9=2a+0b+7c	5	29=4a+12b+13c	10	=6a+16b+16c	7
10=3a+0b+7c	10	30=4a+12b+14c	5	39=5a+18b+16c	9
11=3a+0b+8c	8	31=4a+12b+15c	6	=6a+17b+16c	5
12=3a+0b+9c	9	=5a+12b+14c	9	40=5a+19b+16c	9
13=4a+0b+9c	6	32=4a+13b+15c	5	=5a+20b+15c	4
14=4a+0b+10c	5	=5a+13b+14c	8	=6a+18b+16c	7
15=4a+1b+10c	8	33=4a+14b+15c	6	41=5a+20b+16c	10
16=4a+1b+11c	1	=5a+13b+15c	5	=6a+18b+17c	9
=4a+2b+10c	6	=6a+13b+14c	5	=6a+19b+16c	6
17=4a+3b+10c	5	34=4a+14b+16c	8	42=5a+21b+16c	5
18=4a+4b+10c	6	=5a+14b+15c	6	=6a+19b+17c	8
19=4a+4b+11c	1	=6a+16b+12c	1	43=5a+22b+16c	1
=4a+5b+10c	8	35=4a+15b+16c	5	=6a+20b+17c	6
20=4a+5b+11c	5	=5a+14b+16c	7	44=5a+23b+16c	5
21=4a+6b+11c	6	=5a+15b+15c	6	=6a+21b+17c	7
22=4a+6b+12c	8	=6a+16b+13c	1	45=5a+23b+17c	6
23=4a+6b+13c	5	36=4a+16b+16c	10	=6a+20b+19c	10
=4a+5b+14c	1	=5a+16b+15c	8	=6a+22b+17c	10
24=4a+7b+13c	6	=6a+16b+14c	1	46=5a+23b+18c	6
25=4a+8b+13c	9	37=4a+17b+16c	4	=6a+22b+18c	1
26=4a+9b+13c	4	=5a+13b+19c	1	47=5a+24b+18c	8
27=4a+10b+13c	10	=5a+16b+16c	5	=6a+23b+18c	11
=6a+6b+15c	1	=6a+15b+16c	1	48=5a+25b+18c	6

48=6a+24b+18c	8	52=6a+29b+17c	1	57=6a+32b+19c	7
49=6a+15b+18c	4	53=6a+29b+18c	8	58=6a+32b+20c	6
50=6a+26b+18c	5	54=6a+29b+19c	5	59=6a+33b+20c	4
51=6a+27b+18c	5	55=6a+30b+19c	6		
52=6a+28b+18c	6	56=6a+31b+19c	9		

Table 8. Frequency of observation of each stage in the ontogeny of midrib of *Gr. decipiens* (SCHULTZ.) LINDB.

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+0b+5c	7	25=4a+6b+15c	6	34=5a+14b+15c	1
8=2a+0b+6c	5	=5a+5b+15c	5	=6a+8b+20c	7
9=2a+0b+7c	6	=5a+6b+14c	1	=6a+7b+21c	8
=3a+0b+6c	9	=6a+3b+16c	8	35=4a+15b+16c	1
10=2a+0b+8c	9	26=4a+7b+15c	8	=5a+13b+17c	6
=3a+0b+7c	8	=5a+6b+15c	4	=6a+9b+20c	5
11=3a+0b+8c	5	=5a+3b+18c	1	=6a+8b+21c	9
12=3a+0b+9c	6	=6a+3b+17c	6	=7a+7b+21c	5
13=3a+0b+10c	6	27=4a+8b+15c	7	=7a+6b+22c	1
=4a+0b+9c	10	=5a+7b+15c	9	36=5a+13b+18c	7
14=3a+0b+11c	7	=5a+6b+16c	5	=6a+10b+20c	6
=4a+0b+10c	4	=5a+4b+18c	1	=6a+9b+21c	6
15=4a+0b+11c	7	=5a+5b+17c	1	=7a+8b+21c	9
16=4a+1b+11c	10	=6a+4b+17c	10	37=5a+14b+18c	9
=5a+0b+11c	6	=6a+3b+18c	7	=6a+11b+20c	9
17=4a+1b+12c	8	28=4a+9b+15c	4	=6a+10b+21c	5
=4a+2b+11c	12	=5a+7b+16c	7	=7a+99b+21c	6
=5a+0b+12c	5	=5a+8b+15c	8	38=5a+14b+18c	7
18=4a+1b+13c	6	=6a+4b+18c	6	=6a+12b+20c	5
=4a+2b+12c	7	29=4a+10b+15c	9	=6a+11b+21c	4
=5a+0b+13c	4	=5a+7b+17c	8	=7a+10b+21c	7
=6a+0b+12c	10	=5a+8b+16c	5	39=5a+16b+18c	6
19=4a+2b+13c	6	=6a+4b+19c	10	=6a+13b+20c	4
=4a+3b+12c	5	30=4a+11b+15c	6	=6a+12b+21c	8
=4a+4b+11c	1	=5a+8b+17c	5	=7a+11b+21c	10
=5a+0b+14c	8	=5a+11b+14c	1	40=5a+16b+19c	9
=6a+1b+12c	9	=8a+4b+20c	8	=6a+14b+20c	8
20=4a+3b+13c	6	=6a+5b+19c	9	=6a+13b+21c	8
=4a+4b+12c	5	31=4a+12b+15c	6	=7a+12b+21c	9
=5a+0b+15c	8	=5a+9b+17c	4	41=5a+16b+20c	6
=6a+1b+13c	8	=6a+6b+19c	5	=6a+15b+20c	7
21=4a+3b+14c	6	=6a+5b+20c	5	=6a+14b+21c	5
=4a+4b+13c	9	32=4a+13b+15c	6	=6a+16b+19c	9
=5a+1b+15c	11	=4a+14b+14c	1	=6a+13b+22c	1
=6a+1b+14c	8	=5a+10b+17c	9	=7a+13b+21c	6
22=4a+3b+15c	11	=6a+6b+20c	7	42=6a+16b+20c	7
=4a+4b+14c	9	=6a+5b+21c	8	=6a+15b+21c	5
=5a+2b+15c	7	33=4a+13b+16c	10	=6a+17b+19c	8
=6a+2b+14c	6	=4a+14b+15c	1	=7a+14b+21c	10
23=4a+4b+15c	5	=5a+11b+17c	8	43=6a+16b+21c	7
=5a+3b+15c	8	=6a+7b+20c	8	=6a+17b+20c	8
=6a+2b+15c	11	=6a+6b+21c	7	=6a+18b+19c	9
24=4a+5b+15c	4	34=4a+14b+16c	1	=7a+15b+21c	9
=5a+4b+15c	7	=5a+12b+17c	5	44=6a+17b+21c	6
=6a+2b+16c	9	=5a+13b+16c	10	=6a+18b+20c	10

=7a+16b+21c	8	45=7a+17b+21c	6	47=7a+19b+21c	5
45=6a+18b+21c	4	46=7a+18b+21c	7	48=7a+20b+21c	6

Table 9. Frequency of observation of each stage in the ontogeny of midrib of *Gr. apocarpa* var. *conferta* (FUNCK) SPRENG.

Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency	Constitutional formulae of each stage in the ontogeny of midrib	Frequency
7=2a+0b+5c	8	14=2a+2b+10c	5	18=2a+2b+12c	1
8=2a+0b+6c	4	=2a+3b+9c	4	=2a+5b+11c	6
=2a+1b+5c	9	=2a+4b+8c	9	=2a+6b+10c	5
9=2a+0b+7c	5	=2a+5b+7c	1	=3a+2b+13c	1
=2a+1b+6c	8	=3a+2b+9c	1	19=2a+5b+12c	7
=2a+2b+5c	4	15=2a+2b+11c	7	=2a+6b+11c	4
10=2a+1b+7c	6	=2a+3b+10c	6	=2a+7b+10c	1
=2a+2b+6c	5	=2a+4b+9c	5	=3a+3b+13c	1
11=2a+1b+8c	11	=3a+2b+10c	1	=3a+6b+10c	1
=2a+2b+7c	8	16=2a+2b+12c	1	20=2a+6b+12c	8
=2a+3b+6c	4	=2a+3b+11c	10	=3a+4b+13c	1
12=2a+1b+9c	9	=2a+4b+10c	7	21=2a+7b+12c	6
=2a+2b+8c	6	=3a+2b+11c	1	=3a+5b+13c	1
=2a+3b+7c	5	=3a+3b+10c	1	22=2a+8b+12c	5
13=2a+2b+9c	8	=4a+2b+10c	1	23=2a+9b+12c	4
=2a+3b+8c	12	17=2a+4b+11c	5	24=2a+10b+12c	9
=2a+4b+7c	8	=2a+5b+10c	7	25=4a+8b+13c	1
=3a+1b+9c	1	=3a+3b+11c	1		

From these tables, it can be known that the cell number of the **a-part** is less variable and specifically distinct but the values of the **b**-and **c-parts** are more variable and that several structures are at once observed at a certain stage (where the values of **T** are all the same) and further that sometimes the frequency of observation is not centered around a certain constitutional formula. For example, in *Gr. apocarpa* var. *rivularis* f. *acutifolia*, at the stage of **T=28** I observed (1) **4a+13b+11c** ten times, (2) **5a+14b+9c** six times, (3) **6a+12b+10c** once, (4) **7a+11b+10c** once. I discard the single occurrence of **6a+12b+10c** and **7a+11b+10c** as accidental and take into consideration only the remaining two fomulae. I should not consider any of these as negligible though I notice differences in the number of the times of observation for these structures. I, therefore, have to allow for a degree of variation in the structure at this stage. This is true not only of each stage of ontogeny of the midrib but also of the final completed structure. However, in representing the completed structure, I use as typical the structure which has been frequently observed. I have to make it clear that the procedure for simplification has been taken merely for the sake of convenience.

Next to note is that, in the following tables showing the results of observation in *Gr. apocarpa* var. *conferta* (FUNCK.) BOUL., etc., I mark the formulae of discontinuous structure in gothic type. Since I am conducting my observation of ontogeny of the midrib progressively from the young stage to the maturer stage, I am very likely to obtain continuous structures. I consider it proper, therefore, to discard the discontinuous structures. Though most of them occur infrequently, a few of them occur several times. Even in such cases, I consider it natural to discard them. The reason is that the presence of discontinuous structures is probably due to the inadequacy of the selection of the cross section.

Table 10. Succession of stages in the ontogeny of midrib of *Gr. apocarpa* var. *conferta* (FUNCK) SPRENG.

7=2a+0b+5c	16=**3a+2b+11c=3a+3b+10c=4a+2b+10c**
8=2a+0b+6c=2a+1b+5c	17=2a+4b+11c=2a+5b+10c=**3a+3b+11c**
9=2a+0b+7c=2a+1b+6c=2a+2b+5c	18=2a+4b+12c=2a+5b+11c=2a+6b+10c =**3a+2b+13c**
10=2a+1b+7c=2a+2b+6c	19=2a+5b+12c=2a+6b+11c=**2a+7b+10c =3a+3b+13c=3a+6b+10c**
11=2a+1b+8c=2a+2b+7c=2a+3b+6c	20=2a+6b+12c=**3a+4b+13c**
12=2a+1b+9c=2a+2b+8c=2a+3b+7c	21=2a+7b+12c=**3a+5b+13c**
13=2a+2b+9c=2a+3b+8c=2a+4b+7c =**3a+1b+9c**	22=2a+8b+12c
14=2a+2b+10c=2a+3b+9c=2a+4b+8c =**2a+5b+7c=3a+2b+9c**	23=2a+9b+12c
15=2a+2b+11c=2a+3b+10c=2a+4b+9c =**3a+2b+10c**	24=2a+10b+12c
16=**2a+2b+12c**=2a+3b+11c=2a+4b+10c	25=**4a+8b+13c**

Table 11. Succession of stages in the ontogeny of midrib of *Gr. anomala* HAMPE.

7=2a+0b+5c	30=2a+12b+16c=2a+13b+15c=2a+14b+14c =2a+15b+13c
8=2a+0b+6c	31=2a+13b+16c=2a+14b+15c=2a+15b+14c =2a+16b+13c
9=2a+0b+7c=2a+1b+6c	32=2a+14b+16c=3a+15b+15c=2a+16b+14c =2a+17b+13c
10=2a+0b+8c=2a+1b+7c=2a+2b+6c	33=2a+14b+17c=2a+15b+16c=2a+16b+15c =2a+17b+14c
11=2a+1b+8c=2a+2b+7c	34=2a+15b+17c=2a+16b+16c=2a+17b+15c =2a+18b+14c=**2a+19b+13c**
12=2a+2b+8c=2a+3b+7c	35=**2a+14b+19c=2a+15b+18c**=2a+16b+17c =2a+17b+16c=2a+18b+15c=**2a+19b+14c =2a+20b+13c=5a+14b+16c**
13=2a+2b+9c=2a+3b+8c	36=2a+17b+17c=2a+18b+16c=2a+19b+15c =**2a+20b+14c**
14=2a+3b+9c=2a+4b+8c	37=2a+17b+18c=2a+18b+17c=2a+19b+16c =**2a+20b+15c**
15=2a+3b+10c=2a+4b+9c	38=2a+18b+18c=2a+19b+17c=2a+20b+16c
16=2a+4b+10c=2a+5b+9c=**2a+6b+8c**	39=2a+19b+18c=2a+20b+17c
17=2a+5b+10c=2a+6b+9c=**2a+7b+8c =2a+8b+7c**	40=2a+20b+18c=2a+21b+17c
18=2a+5b+11c=2a+7b+9c	41=2a+21b+18c
19=2a+6b+11c=2a+8b+9c	42=2a+22b+18c
20=2a+6b+12c=2a+8b+10c	43=2a+23b+18c
21=2a+7b+12c=2a+8b+11c=**3a+7b+11c**	44=2a+24b+18c
22=2a+8b+12c=2a+9b+11c=**2a+10b+10c**	45=2a+25b+18c
23=2a+9b+12c=2a+10b+11c=**3a+9b+11c =3a+10b+10c**	46=2a+26b+18c
24=2a+9b+13c=2a+10b+12c=2a+11b+11c	47=2a+27b+18c
25=2a+9b+14c=2a+10b+13c=2a+11b+12c =2a+12b+11c	48=2a+28b+18c
26=2a+10b+14c=2a+11b+13c=2a+12b+12c	
27=2a+11b+14c=2a+12b+13c	
28=2a+11b+15c=2a+12b+14c=2a+13b+13c =**2a+10b+16c**	
29=2a+11b+16c=2a+12b+15c=2a+13b+14c =2a+14b+13c=**4a+11b+14c**	

Table 12. Succession of stages in the ontogeny of midrib of *Gr. funalis* var. *calvescens* (KINDB.) MOELL.

7=2a+0b+5c=2a+1b+4c	14=3a+1b+10c=3a+2b+9c=**3a+3b+8c**
8=2a+0b+6c=2a+1b+5c=3a+0b+5c	=4a+0b+10c=4a+1b+9c=5a+0b+9c
9=2a+0b+7c=2a+1b+6c=3a+0b+6c	15=4a+1b+10c=4a+2b+9c=5a+0b+10c
10=2a+1b+7c=2a+2b+6c=**2a+3b+5c**	16=**4a+4b+8c**=4a+2b+10c=5a+1b+10c
=3a+0b+7c=3a+1b+6c	=5a+2b+9c
11=2a+1b+8c=2a+2b+7c=**2a+3b+6c**	17=4a+2b+11c=5a+2b+10c=**5a+3b+9c**
=3a+0b+8c=3a+2b+6c	=**6a+1b+10c**=**6a+0b+11c**
12=3a+1b+8c=3a+2b+7c=4a+0b+8c	18=**5a+3b+10c**=5a=2b+11c
=4a+1b+7c	19=5a+2b+12c
13=4a+0b+9c=4a+1b+8c=3a+1b+9c	
=3a+2b+8c	

Table 13. Succession of stages in the ontogeny of midrib of *Gr. agassizii* (SULL. et LESQ.) JAEG.

7=2a+2b+3c	18=2a+8b+8c=2a+9b+7c=2a+10b+6c
8=2a+2b+4c=2a+3b+3c	=**2a+11b+5c**
9=2a+3b+4c	19=2a+9b+8c=2a+10b+7c=2a+11b+6c
10=2a+4b+4c	20=2a+9b+9c=2a+10b+8c=2a+11b+7c
11=2a+4b+5c=2a+5b+4c	=2a+12b+6c
12=2a+5b+5c=2a+6b+4c=**2a+3b+6c**	21=2a+10b+9c=2a+11b+8c=2a+12b+7c
13=2a+5b+6c=2a+6b+5c=2a+7b+4c	=2a+13b+6c
14=2a+6b+6c=2a+7b+5c=2a+8b+4c	22=2a+11b+9c=2a+12b+8c=2a+13b+7c
15=2a+6b+7c=2a+7b+6c=2a+8b+5c	=**3a+12b+7c**
16=2a+7b+7c=2a+8b+6c=**2a+5b+9c**	23=2a+12b+9c=2a+13b+8c=2a+14b+7c
17=2a+7b+8c=2a+8b+7c=2a+9b+6c	=**3a+11b+9c**
=**2a+10b+5c**	24=2a+14b+8c=2a+13b+9c=**3a+13b+8c**

Table 14. Succession of stages in the ontogeny of midrib of *Gr. apocarpa* var. *rivularis* f. *acutifolia* (T. JENS.).

7=2a+1b+4c=**3a+0b+4c**	21=4a+10b+7c=5a+8b+8c=**4a+11b+6c**
8=2a+2b+4c	=**5a+7b+9c**=**5a+9b+7c**=**6a+8b+7c**
9=2a+3b+4c	=**6a+7b+8c**
10=2a+3b+5c=2a+4b+4c=3a+3b+4c	22=4a+10b+8c=5a+9b+8c=**6a+8b+8c**
11=2a+3b+6c=2a+4b+5c=3a+3b+5c	23=4a+11b+8c=5a+10b+8c=**6a+9b+9c**
=3a+4b+4c	24=4a+11b+9c=5a+11b+8c=**6a+8b+10c**
12=2a+4b+6c=2a+5b+5c=3a+4b+5c	=**6a+9b+9c**=**7a+8b+9c**
=4a+3b+5c	25=5a+12b+8c=4a+12b+9c
13=2a+5b+6c=2a+6b+5c=3a+4b+6c	26=**4a+14b+8c**=4a+12b+10c=5a+13b+8c
=**3a+6b+4c**=**4a+3b+6c**=4a+4b+5c	=**6a+12b+8c**=**7a+8b+11c**=**6a+10b+10c**
14=2a+7b+5c=3a+5b+6c=**4a+4b+6c**	27=4a+12b+11c=5a+13b+9c=**7a+10b+10c**
=**5a+3b+6c**=**5a+4b+5c**=4a+5b+5c	=**8a+9b+10c**
15=2a+8b+5c=3a+6b+6c=**4a+5b+6c**	28=4a+13b+11c=5a+14b+9c=**6a+12b+10c**
=**5a+4b+6c**=4a+6b+5c	=**7a+11b+10c**
16=3a+7b+6c=3a+8b+5c=4a+7b+5c	29=4a+14b+11c=5a+14b+10c=**5a+12b+10c**
=**5a+4b+7c**	=**6a+12b+11c**=**6a+13b+10c**
17=3a+7b+7c=3a+8b+6c=4a+8b+5c	30=4a+15b+11c=5a+15b+10c=5a+14b+11c
18=3a+8b+7c=4a+8b+6c=**4a+6b+8c**	=**6a+15b+9c**=**7a+13b+10c**
19=3a+9b+7c=4a+8b+7c=**5a+7b+7c**	31=4a+16b+11c=5a+15b+11c
=**5a+8b+6c**	32=4a+16b+12c=5a+16b+11c
20=3a+10b+7c=4a+8b+8c=**5a+6b+9c**	33=5a+16b+12c
=**5a+7b+9c**	34=5a+17b+12c
	35=5a+28b+12c

Table 15. Succession of stages in the ontogeny of midrib of *Gr. trichophylla* f. *robusta* PODP.

7=2a+0b+5c
8=2a+0b+6c
9=2a+0b+7c
10=3a+0b+7c
11=3a+0b+8c
12=3a+0b+9c
13=4a+0b+9c
14=4a+0b+10c
15=4a+1b+10c
16=**4a+1b+11c**=4a+2b+10c
17=4a+3b+10c
18=4a+4b+10c
19=**4a+2b+11c**=4a+5b+10c
20=4a+5b+11c
21=4a+6b+11c
22=4a+6b+12c
23=4a+6b+13c=**4a+5b+14c**
24=4a+7b+13c
25=4a+8b+13c
26=4a+9b+13c
27=4a+10b+13c=**6a+6b+15c**=**6a+7b+14c**
28=4a+11b+13c
29=4a+12b+13c
30=4a+12b+14c
31=4a+12b+15c=5a+12b+14c
32=4a+13b+15c=5a+13b+14c
33=4a+14b+15c=5a+13b+15c=6a+13b+14c
34=4a+14b+16c=5a+14b+15c=**6a+16b+12c**
35=4a+15b+16c=5a+14b+16c=5a+15b+15c
=**6a+16b+13c**
36=4a+16b+16c=5a+16b+15c=**6a+16b+14c**
37=4a+17b+16c=**5a+13b+19c**=5a+16b+16c
=**6a+15b+16c**=6a+16b+15c
38=5a+17b+16c=6a+16b+16c
39=5a+18b+16c=6a+17b+16c
40=5a+19b+16c=**5a+20b+15c**=6a+18b+16c
41=5a+20b+16c=6a+18b+17c=6a+19b+16c
42=5a+21b+16c=6a+19b+17c
43=5a+22b+16c=6a+20b+17c
44=5a+23b+16c=6a+21b+17c
45=5a+23b+17c=**6a+20b+19c**=6a+22b+17c
46=5a+23b+18c=6a+22b+18c
47=5a+24b+18c=6a+23b+18c
48=5a+25b+18c=6a+24b+18c
49=6a+25b+18c
50=6a+26b+18c
51=6a+27b+18c
52=6a+28b+18c=**6a+29b+17c**
53=6a+29b+18c
54=6a+29b+19c
55=6a+30b+19c
56=6a+31b+19c
57=6a+32b+19c
58=6a+32b+20c
59=6a+33b+20c

Table 16. Succession of stages in the ontogeny of midrib of *Gr. decipiens* (SCHULTZ.) LINDB.

7=2a+0b+5c
8=2a+0b+6c
9=2a+0b+7c=3a+0b+6c
10=2a+0b+8c=3a+0b+7c
11=3a+0b+8c
12=3a+0b+9c
13=3a+0b+10c=4a+0b+9c
14=3a+0b+11c=4a+0b+10c
15=4a+0b+11c
16=4a+1b+11c=5a+0b+11c
17=4a+1b+12c=4a+2b+11c=5a+0b+12c
18=4a+1b+13c=4a+2b+12c=5a+0b+13c
=6a+0b+12c
19=4a+4b+11c
=5a+0b+14c=6a+1b+12c
20=4a+3b+13c=4a+4b+12c=5a+0b+15c
=6a+1b+13c
21=4a+3b+14c=4a+4b+13c=5a+1b+15c
=6a+1b+14c
22=4a+3b+15c=4a+4b+14c=5a+2b+15c
=6a+2b+14c
23=4a+4b+15c=5a+3b+15c=6a+2b+15c
24=4a+5b+15c=5a+4b+15c=6a+2b+16c
25=4a+6b+15c=5a+5b+15c=**5a+6b+14c**
=6a+3b+16c
26=4a+7b+15c=5a+6b+15c=**5a+3b+18c**
=6a+3b+17c
27=4a+8b+15c=5a+7b+15c=5a+6b+16c
=**5a+4b+18c**=**5a+5b+17c**=**6a+4b+17c**
=6a+3b+18c
28=4a+9b+15c=5a+7b+16c=5a+8b+15c
=6a+4b+18c
29=4a+10b+15c=5a+7b+17c=5a+8b+16c
=6a+4b+19c
30=4a+11b+15c=5a+8b+17c=**5a+11b+14c**
=6a+4b+20c=6a+5b+19c
31=4a+12b+15c=5a+9b+17c=6a+6b+19c
=6a+5b+20c
32=4a+13b+15c=**4a+14b+14c**=5a+10b+17c
=6a+6b+20c=6a+5b+21c
33=4a+13b+16c=**4a+14b+15c**=5a+11b+17c
=6a+7b+20c=6a+6b+21c
34=**4a+14b+16c**=5a+12b+17c=5a+13b+16c
=5a+14b+15c=6a+8b+20c=6a+7b+21c
35=**4a+15b+16c**=5a+13b+17c=6a+9b+20c
=6a+8b+21c=7a+7b+21c=**7a+6b+22c**

36=5a+13b+18c=6a+10b+20c=6a+ 9b+21c =7a+ 8b+21c	41=5a+16b+20c=6a+15b+20c=6a+14b+21c =6a+16b+19c=**6a+13b+22c**=7a+13b+21c
37=5a+14b+18c=6a+11b+20c=6a+10b+21c =7a+ 9b+21c	42=6a+16b+20c=6a+15b+21c=6a+17b+19c =7a+14b+21c
38=5a+15b+18c=6a+12b+20c=6a+11b+21c =7a+10b+21c	43=6a+16b+21c=6a+17b+20c=6a+18b+19c =7a+15b+21c
39=5a+16b+18c=6a+13b+20c=6a+12b+21c =7a+11b+21c	44=6a+17b+21c=6a+18b+20c=7a+16b+21c
40=5a+16b+19c=6a+14b+20c=6a+13b+21c =7a+12b+21c	45=6a+18b+21c=7a+17b+21c
	46=7a+18b+21c
	47=7a+19b+21c
	48=7a+20b+21c

When I observe the cross section of the midrib, I notice that the morphology of the cells in certain species shows specificity depending on which part they are from. In other species, however, this specificity is not so distinct. Taking these facts into consideration I make my observation of the midrib tissue. In the **fourty-one** species of *Grimmia* treated, the ontogeny of their midribs is observed and the following constitutional formulae are obtained:

Table 17. Conclusive series of stages in the ontogeny of midrib of *Gr. agassizii* (SULL. et LESQ.) JAEG.

7=2a+2b+3c	17=2a+7b+8c=2a+8b+7c=2a+9b+6c
8=2a+2b+4c=2a+3b+3c	18=2a+8b+8c=2a+9b+7c=2a+10b+6c
9=2a+3b+4c	19=2a+9b+8c=2a+10b+7c=2a+11b+6c
10=2a+4b+4c	20=2a+9b+9c=2a+10b+8c=2a+11b+7c =2a+12b+6c
11=2a+4b+5c=2a+5b+4c	21=2a+10b+9c=2a+11b+8c=2a+12b+7c =2a+13b+6c
12=2a+5b+5c=2a+6b+4c	22=2a+11b+9c=2a+12b+8c=2a+13b+7c
13=2a+5b+6c=2a+6b+5c=2a+7b+4c	23=2a+12b+9c=2a+13b+8c=2a+14b+7c
14=2a+6b+6c=2a+7b+5c=2a+8b+4c	24=2a+13b+9c
15=2a+6b+7c=2a+7b+6c=2a+8b+5c	
16=2a+7b+7c=2a+8b+6c	

Table 18. Conclusive series of stages in the ontogeny of midrib of *Gr. alpicola* HEDW.

7=2a+1b+4c	13=2a+3b+8c
8=2a+1b+5c	14=2a+4b+8c
9=2a+2b+5c	15=2a+4b+9c=2a+5b+8c
10=2a+2b+6c	16=2a+5b+9c=2a+6b+8c
11=2a+2b+7c	17=2a+6b+9c
12=2a+2b+8c=2a+3b+7c	

Table 19. Conclusive series of stages in the ontogeny of midrib of *Gr. anodon* B. S. G.

7=2a+1b+4c	15=3a+4b+8c=3a+4b+8c=3a+5b+7c
8=2a+1b+5c=2a+2b+4c	16=3a+5b+8c=4a+4b+8c
9=2a+2b+5c=2a+3b+4c	17=4a+5b+8c=5a+4b+8c
10=2a+3b+5c=2a+4b+4c	18=5a+4b+9c=5a+5b+8c=6a+4b+8c
11=2a+3b+6c=2a+4b+5c=3a+3b+5c	19=6a+4b+9c=6a+5b+8c
12=2a+4b+6c=2a+5b+5c=3a+3b+6c	20=6a+5b+9c
13=2a+5b+6c=3a+4b+6c	21=7a+5b+9c
14=2a+5b+7c=3a+4b+7c	

Table 20. Conclusive series of stages in the ontogeny of midrib of *Gr. anomala* HAMPE.

7=2a+0b+5c	29=2a+11b+16c=2a+12b+15c=2a+13b+14c =2a+14b+13c
8=2a+0b+6c	30=2a+12b+16c=2a+13b+15c=2a+14b+14c =2a+15b+13c
9=2a+0b+7c=2a+1b+6c	31=2a+13b+16c=2a+14b+15c=2a+15b+14c =2a+16b+13c
10=2a+0b+8c=2a+1b+7c=2a+2b+6c	32=2a+14b+16c=2a+15b+15c=2a+16b+14c
11=2a+1b+8c=2a+2b+7c	33=2a+14b+17c=2a+15b+16c=2a+16b+15c
12=2a+2b+8c=2a+3b+7c	34=2a+15b+17c=2a+16b+16c=2a+17b+15c
13=2a+2b+9c=2a+3b+8c	35=2a+16b+17c=2a+17b+16c=2a+18b+15c
14=2a+3b+9c=2a+4b+8c	36=2a+17b+17c=2a+18b+16c=2a+19b+15c
15=2a+3b+10c=2a+4b+9c	37=2a+17b+18c=2a+18b+17c=2a+19b+16c
16=2a+4b+10c=2a+5b+9c	38=2a+18b+18c=2a+19b+17c=2a+20b+16c
17=2a+5b+10c=2a+6b+9c	39=2a+19b+18c=2a+20b+17c
18=2a+5b+11c=2a+7b+9c	40=2a+20b+18c=2a+21b+17c
19=2a+6b+11c=2a+8b+9c	41=2a+21b+18c
20=2a+6b+12c=2a+8b+10c	42=2a+22b+18c
21=2a+7b+12c=2a+8b+11c	43=2a+23b+18c
22=2a+8b+12c=2a+9b+11c	44=2a+24b+18c
23=2a+9b+12c=2a+10b+11c	45=2a+25b+18c
24=2a+9b+13c=2a+10b+12c=2a+11b+11c	46=2a+26b+18c
25=2a+9b+14c=2a+10b+13c=2a+11b+12c =2a+12b+11c	47=2a+27b+18c
26=2a+10b+14c=2a+11b+13c=2a+12b+12c	48=2a+28b+18c
27=2a+11b+14c=2a+12b+13c	
28=2a+11b+15c=2a+12b+14c=2a+13b+13c	

Table 21. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* HEDW.

7=2a+0b+5c	18=2a+6b+10c
8=2a+0b+6c	19=2a+7b+10c
9=2a+1b+6c	20=2a+8b+10c
10=2a+1b+7c=2a+2b+6c	21=2a+8b+11c
11=2a+2b+7c	22=2a+9b+11c
12=2a+2b+8c=2a+3b+7c	23=2a+9b+12c=2a+10b+11c
13=2a+3b+8c	24=2a+10b+12c=2a+11b+11c
14=2a+3b+9c	25=2a+11b+12c=2a+12b+11c
15=2a+4b+9c	26=2a+12b+12c=2a+13b+11c
16=2a+5b+9c	27=2a+13b+12c
17=2a+5b+10c=2a+6b+9c	

Table 22. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* var. *atrofusca* (SCHIMP.) HUSN.

7=2a+1b+4c	15=2a+5b+8c=2a+6b+7c
8=2a+1b+5c=2a+2b+4c	16=2a+5b+9c=2a+6b+8c
9=2a+2b+5c	17=2a+6b+9c=2a+7b+8c
10=2a+2b+6c	18=2a+7b+9c=2a+8b+8c
11=2a+3b+6c	19=2a+8b+9c=2a+9b+8c
12=2a+3b+7c=2a+4b+6c	20=2a+9b+9c
13=2a+3b+8c=2a+4b+7c	21=2a+9b+10c
14=2a+4b+8c=2a+5b+7c	22=2a+10b+10c

Table 23. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* var. *conferta* (FUNCK) SPRENG.

7=2a+0b+5c	16=2a+3b+11c=2a+4b+10c
8=2a+0b+6c=2a+1b+5c	17=2a+4b+11c=2a+5b+10c
9=2a+0b+7c=2a+1b+6c=2a+2b+5c	18=2a+5b+11c=2a+6b+10c
10=2a+1b+7c=2a+2b+6c	19=2a+5b+12c=2a+6b+11c
11=2a+1b+8c=2a+2b+7c=2a+3b+6c	20=2a+6b+12c
12=2a+1b+9c=2a+2b+8c=2a+3b+7c	21=2a+7b+12c
13=2a+2b+9c=2a+3b+8c=2a+4b+7c	22=2a+8b+12c
14=2a+2b+10c=2a+3b+9c=2a+4b+8c	23=2a+9b+12c
15=2a+2b+11c=2a+3b+10c=2a+4b+9c	24=2a+10b+12c

Table 24. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* var. *microtheca* CARD.

7=2a+0b+5c	17=2a+7b+8c
8=2a+1b+5c	18=2a+8b+8c
9=2a+1b+6c	19=2a+9b+8c
10=2a+1b+7c	20=2a+10b+8c
11=2a+2b+7c	21=2a+10b+9c
12=2a+2b+8c=2a+3b+7c	22=2a+10b+10c
13=2a+3b+8c	23=2a+11b+10c=2a+10b+11c
14=2a+4b+8c	24=2a+11b+11c=2a+12+10c
15=2a+5b+8c	25=2a+12b+11c
16=2a+6b+8c	

Table 25. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* var. *rivularis* (BRID.) NEES et HORNSCH.

7=2a+1b+4c	15=2a+6b+7c=2a+7b+6c
8=2a+2b+4c	16=2a+7b+7c
9=2a+3b+4c	17=2a+7b+8c=2a+8b+7c
10=2a+3b+5c	18=2a+8b+8c=2a+9b+7c
11=2a+3b+6c=2a+4b+5c	19=2a+9b+8c=2a+10b+7c
12=2a+4b+6c	20=2a+10b+8c
13=2a+5b+6c	21=2a+11b+8c=2a+10b+9c
14=2a+5b+7c=2a+6b+6c	

Table 26. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* var. *rivularis* f. *acutifolia* (T. JENS.).

7=2a+1b+4c	17=3a+7b+7c=3a+8b+6c=4a+8b+5c
8=2a+2b+4c	18=3a+8b+7c=4a+8b+6c
9=2a+3b+4c	19=3a+9b+7c=4a+8b+7c
10=2a+3b+5c=2a+4b+4c=3a+3b+4c	20=3a+10b+7c=4a+8b+8c
11=2a+3b+6c=2a+4b+5c=3a+3b+5c =3a+4b+4c	21=4a+10b+7c=5a+8b+8c
12=2a+4b+6c=2a+5b+5c=3a+4b+5c	22=4a+10b+8c=5a+9b+8c
13=2a+5b+6c=2a+6b+5c=3a+4b+6c =4a+4b+5c	23=4a+11b+8c=5a+10b+8c
14=2a+7b+5c=3a+5b+6c=4a+5b+5c	24=4a+11b+9c=5a+11b+8c
15=2a+8b+5c=3a+6b+6c=4a+6b+5c	25=5a+12b+8c=4a+12b+9c
16=3a+7b+6c=3a+8b+5c=4a+7b+5c	26=4a+12b+10c=5a+13b+8c
	27=4a+12b+11c=5a+13b+9c
	28=4a+13b+11c=5a+14b+9c

29=4a+14b+11c=5a+14b+10c	33=5a+16b+12c
30=4a+15b+11c=5a+15b+10c=5a+14b+11c	34=5a+17b+12c
31=4a+16b+11c=5a+15b+11c	35=5a+18b+12c
32=4a+16b+12c=5a+16b+11c	

Table 27. Conclusive series of stages in the ontogeny of midrib of *Gr. apocarpa* var. *tenerrima* NEES et HORNSCH.

7=2a+0b+5c	20=4a+6b+10c=4a+5b+11c
8=2a+0b+6c=2a+1b+5c	21=4a+5b+12c=4a+6b+11c=4a+7b+10c
9=2a+1b+6c	22=4a+6b+12c=4a+7b+11c=5a+7b+10c
10=2a+2b+6c	23=4a+6b+13c=4a+7b+12c=5a+7b+11c
11=2a+2b+7c=2a+3b+6c	24=4a+7b+13c=5a+7b+12c=5a+8b+11c
12=2a+2b+8c=2a+3b+7c=2a+4b+6c	25=4a+8b+13c=5a+8b+12c=5a+9b+11c
13=2a+4b+7c=3a+2b+8c	26=4a+9b+13c=5a+9b+12c=5a+10b+11c
14=3a+2b+9c=3a+4b+7c	27=5a+10b+12c=6a+9b+12c=6a+10b+11c
15=3a+4b+8c=4a+2b+9c	28=5a+11b+12c=6a+10b+12c=6a+11b+11c
16=3a+4b+9c=4a+2b+10c=4a+3b+9c	29=6a+11b+12c=6a+12b+11c
=4a+4b+8c	30=6a+12b+12c
17=3a+4b+10c=3a+5b+9c=4a+3b+10c	31=6a+12b+13c
=4a+4b+9c	32=6a+12b+14c
18=3a+6b+9c=4a+3b+11c=4a+4b+10c	33=6a+12b+15c=6a+13b+14c
=4a+5b+9c	34=6a+13b+15c
19=4a+4b+11c=4a+5b+10c=4a+6b+9c	

Table 28. Conclusive series of stages in the ontogeny of midrib of *Gr. arizonae* REN. et CARD.

7=2a+0b+5c	36=5a+11b+20c
8=2a+0b+6c	37=5a+12b+20c
9=2a+0b+7c	38=6a+12b+20c
10=2a+0b+8c	39=6a+13b+20c
11=2a+0b+9c=2a+1b+8c	40=6a+14b+20c
12=2a+1b+9c	41=6a+15b+20c
13=2a+2b+9c	42=6a+16b+20c
14=2a+2b+10c	43=6a+17b+20c=7a+16b+20c
15=2a+3b+10c=3a+2b+10c	44=6a+18b+20c=7a+17b+20c
16=2a+3b+11c=3a+3b+10c	45=6a+18b+21c=7a+18b+20c
17=2a+4b+11c=3a+4b+10c	46=6a+19b+21c=7a+18b+21c
18=3a+4b+11c	47=6a+20b+21c=7a+19b+21c=8a+18b+21c
19=3a+5b+11c	48=6a+21b+21c=7a+19b+21c=8a+18b+21c
20=3a+5b+12c	49=6a+22b+21c=7a+21b+21c=8a+20b+21c
21=3a+6b+12c	50=6a+22b+22c=7a+22b+21c=8a+21b+21c
22=3a+7b+12c	51=6a+23b+22c=7a+22b+22c=8a+22b+21c
23=3a+8b+12c	52=7a+23b+22c=8a+22b+22c
24=3a+8b+13c	53=7a+23b+23c=8a+23b+22c
25=3a+9b+13c	54=7a+23b+24c=8a+23b+23c
26=3a+9b+14c	55=7a+23b+25c=8a+23b+24c
27=3a+9b+15c	56=8a+23b+25c=9a+23b+24c
28=3a+10b+15c	57=8a+24b+25c=9a+24b+24c
29=3a+10b+16c	58=8a+25b+25c=9a+24b+25c
30=4a+10b+16c	59=8a+26b+25c=9a+25b+25c
31=4a+10b+17c	60=8a+27b+25c=9a+26b+25c=10a+25b+25c
32=4a+10b+18c	61=8a+28b+25c=9a+27b+25c=10a+26b+25c
33=4a+10b+19c	62=8a+28b+26c=9a+28b+25c=10a+27b+25c
34=5a+10b+19c	63=8a+29b+26c=9a+28b+26c=10a+28b+25c
35=5a+10b+20c	64=8a+30b+26c=9a+29b+26c=10a+29b+25c

65=9a+30b+26c=10a+29b+26c	81=11a+37b+33c
66=9a+30b+27c=10a+30b+26c	82=11a+38b+33c
67=9a+30b+28c=10a+30b+27c	83=11a+38b+34c
68=9a+31b+28c=10a+30b+28c	84=11a+39b+34c
69=9a+31b+29c=10a+31b+28c	85=11a+40b+34c
70=9a+31b+30c=10a+31b+29c	86=11a+40b+35c
71=10a+31b+30c=11a+31b+29c	87=11a+41b+35c
72=10a+32b+30c=11a+31b+30c	88=11a+42b+35c
73=10a+32b+31c=11a+32b+30c	89=11a+43b+35c
74=10a+32b+32c=11a+32b+31c	90=11a+44b+35c
75=10a+32b+33c=11a+32b+32c	91=11a+45b+35c
76=11a+32b+33c	92=11a+46b+35c
77=11a+33b+33c	93=11a+47b+35c
78=11a+34b+33c	94=11a+47b+36c
79=11a+35b+33c	95=11a+48b+36c
80=11a+36b+33c	96=11a+49b+36c

Table 29. Conclusive series of stages in the ontogeny of midrib of *Gr. cratericola* SAK. et TAK.

7=2a+0b+5c	19=4a+6b+9c=5a+3b+11c=5a+4b+10c =5a+5b+9c=6a+3b+10c
8=2a+1b+5c=3a+0b+5c	20=4a+6b+10c=5a+4b+11c=5a+5b+10c =6a+3b+11c
9=3a+1b+5c=3a+0b+6c	21=4a+6b+11c=5a+5b+11c=5a+6b+10c =6a+4b+11c
10=3a+0b+7c=3a+1b+6c	22=5a+5b+12c=5a+6b+11c=6a+5b+11c
11=3a+1b+7c=3a+2b+6c	23=5a+6b+12c=6a+6b+11c
12=3a+2b+7c=4a+1b+7c=4a+2b+6c	24=6a+6b+12c=6a+7b+11c
13=3a+3b+7c=4a+1b+8c=4a+2b+7c	25=6a+7b+12c
14=3a+3b+8c=4a+2b+8c=4a+3b+7c	26=6a+7b+13c
15=3a+3b+9c=4a+2b+9c=4a+3b+8c =5a+2b+8c	27=7a+7b+13c
16=4a+2b+10c=4a+3b+9c=5a+2b+9c	28=7a+7b+14c=7a+8b+13c
17=4a+4b+9c=5a+2b+10c=5a+3b+9c	
18=4a+5b+9c=5a+2b+11c=5a+3b+10c =5a+4b+9c	

Table 30. Conclusive series of stages in the ontogeny of midrib of *Gr. decalvata* CARD.

7=2a+0b+5c	19=2a+7b+10c
8=2a+1b+5c	20=2a+7b+11c
9=2a+1b+6c	21=2a+8b+11c
10=2a+2b+6c	22=2a+8b+12c
11=2a+2b+7c	23=2a+8b+13c=2a+9b+12c
12=2a+3b+7c	24=2a+9b+13c=2a+10b+12c
13=2a+4b+7c	25=2a+10b+13c=2a+11b+12c
14=2a+4b+8c	26=2a+11b+13c=2a+12b+12c
15=2a+5b+8c	27=2a+11b+14c=2a+12b+13c
16=2a+5b+9c	28=2a+12b+14c=2a+13b+13c
17=2a+5b+10c	29=2a+13b+14c
18=2a+6b+10c	30=2a+13b+15c

Table 31. Conclusive series of stages in the ontogeny of midrib of *Gr. decipiens* (SCHULTZ.) LINDB.

7=2a+0b+5c	30=6a+5b+19c
8=2a+0b+6c	31=4a+12b+15c=5a+9b+17c=6a+6b+19c
9=2a+0b+7c=3a+0b+6c	=6a+5b+20c
10=2a+0b+8c=3a+0b+7c	32=4a+13b+15c+5a+10b+17c=6a+6b+20c
11=3a+0b+8c	=6a+5b+21c
12=3a+0b+9c	33=4a+13b+16c=5a+11b+17c=6a+7b+20c
13=3a+0b+10c=4a+0b+9c	=6a+6b+20c
14=3a+0b+11c=4a+0b+10c	34=5a+12b+17c=5a+13b+16c=6a+8b+20c
15=4a+0b+11c	=6a+7b+21c
16=4a+1b+11c=5a+0b+11c	35=5a+13b+17c=6a+9b+20c=6a+8b+21c
17=4a+1b+12c=4a+2b+11c=5a+0b+12c	=7a+7b+21c
18=4a+1b+13c=4a+2b+12c=5a+0b+13c	36=5a+13b+18c=6a+10b+20c=6a+9b+21c
=6a+0b+12c	=7a+8b+21c
19=4a+2b+13c=4a+3b+12c=5a+0b+14c	37=5a+14b+18c=6a+11b+20c=6a+10b+21c
=6a+1b+12c	=7a+9b+21c
20=4a+3b+13c=4a+4b+12c=5a+0b+15c	38=5a+15b+18c=6a+12b+20c=6a+11b+21c
=6a+1b+13c	=7a+10b+21c
21=4a+3b+14c=4a+4b+13c=5a+1b+15c	39=5a+16b+18c=6a+13b+20c=6a+12b+21c
=6a+1b+14c	=7a+11b+21c
22=4a+3b+15c=4a+4b+14c=5a+2b+15c	40=5a+16b+19c=6a+14b+20c=6a+13b+21c
=6a+2b+14c	=7a+12b+21c
23=4a+4b+15c=5a+3b+15c=6a+2b+15c	41=5a+16b+20c=6a+15b+20c=6a+14b+21c
24=4a+5b+15c=5a+4b+15c=6a+2b+16c	=62+16b+19c=7a+13b+21c
25=4a+6b+15c=5a+5b+15c=6a+3b+16c	42=6a+16b+20c=6a+15b+21c=6a+17b+19c
26=4a+7b+15c=5a+6b+15c=6a+3b+17c	=7a+14b+21c
27=4a+8b+15c=5a+7b+15c=5a+6b+16c	43=6a+16b+21c=6a+17b+20c=6a+18b+19c
=6a+4b+17c=6a+3b+18c	=7a+15b+21c
28=4a+9b+15c=5a+7b+16c=5a+8b+15c	44=6a+17b+21c=6a+18b+20c=7a+16b+21c
=6a+4b+18c	45=6a+18b+21c=7a+17b+21c
29=4a+10b+15c=5a+7b+17c=5a+8b+16c	46=7a+18b+21c
=6a+4b+19c	47=7a+19b+21c
30=4a+11b+15c=5a+8b+17c=6a+4b+20c	48=7a+20b+21c

Table 32. Conclusive series of stages in the ontogeny of midrib of *Gr. donniana* SM.

7=2a+0b+5c	17=2a+7b+8c
8=2a+0b+6c	18=2a+5b+11c=2a+6b+10c=2a+7b+9c
9=2a+0b+7c	=2a+8b+8c
10=2a+0b+8c=2a+1b+7c	19=2a+6b+11c=2a+7b+10c=2a+8b+9c
11=2a+0b+9c=2a+1b+8c=2a+2b+7c	=2a+9b+8c
12=2a+1b+9c=2a+2b+8c=2a+3b+7c	20=2a+7b+11c=2a+8b+10c=2a+9b+9c
13=2a+2b+9c=2a+3b+8c=2a+4b+7c	21=2a+8b+11c=2a+9b+10c
14=2a+2b+10c=2a+3b+9c=2a+4b+8c	22=2a+9b+11c=2a+10b+10c
15=2a+3b+10c=2a+4b+9c=2a+5b+8c	23=2a+10b+11c=2a+11b+10c
16=2a+4b+10c=2a+5b+9c=2a+6b+8c	24=2a+11b+11c
17=2a+4b+11c=2a+5b+10c=2a+6b+9c	

Table 33. Conclusive series of stages in the ontogeny of midrib of *Gr. elatior* BRUCH.

7=2a+0b+5c	10=2a+0b+8c=2a+1b+7c
8=2a+0b+6c	11=2a+1b+8c=2a+2b+7c
9=2a+0b+7c	12=2a+2b+8c=2a+3b+7c

13=2a+3b+8c=2a+4b+7c	21=2a+8b+11c=2a+9b+10c
14=2a+3b+9c=2a+4b+8c	22=2a+9b+11c
15=2a+3b+10c=2a+4b+9c=2a+5b+8c	23=2a+10b+11c
16=2a+4b+10c=2a+5b+9c	24=2a+11b+11c
17=2a+4b+11c=2a+5b+10c	25=2a+12b+11c
18=2a+5b+11c=2a+6b+10c	26=2a+12b+12c
19=2a+6b+11c=2a+7b+10c	27=2a+13b+12c
20=2a+8b+10c=2a+7b+11c	28=2a+14b+12c

Table 34. Conclusive series of stages in the ontogeny of midrid of *Gr. funalis* (SCHWAEGR.) B. S. G.

7=2a+0b+5c	15=2a+3b+10c=2a+4b+9c=2a+5b+8c
8=2a+0b+6c=2a+1b+5c	16=2a+4b+10c=2a+5b+9c=2a+6b+8c
9=2a+0b+7c=2a+1b+6c=2a+2b+5c	17=2a+5b+10c=2a+6b+9c=2a+7b+8c
10=2a+0b+8c=2a+1b+7c=2a+2b+6c	18=2a+6b+10c=2a+7b+9c=2a+8b+8c
11=2a+1b+8c=2a+2b+7c	19=2a+7b+10c=2a+8b+9c
12=2a+2b+8c=2a+3b+7c	20=2a+8b+10c=2a+9b+9c
13=2a+3b+6c=2a+4b+7c	21=2a+9b+10c
14=2a+3b+9c=2a+4b+8c=2a+5b+7c	

Table 35. Conclusive series of stages in the ontogeny of midrib of *Gr. funalis* var. *calvescens* (KINDB.) MOELL.

7=2a+0b+5c=2a+1b+4c	13=4a+0b+9c=4a+1b+8c=3a+1b+9c
8=2a+0b+6c=2a+1b+5c=3a+0b+5c	=3a+2b+8c
9=2a+0b+7c=2a+1b+6c=3a+0b+6c	14=3a+1b+10c=3a+2b+9c=4a+0b+10c
10=2a+1b+7c=2a+2b+6c=3a+0b+7c	=4a+1b+9c=5a+0b+9c
=3a+1b+6c	15=4a+1b+10c=4a+2b+9c=5a+0b+10c
11=2a+1b+8c=2a+2b+7c=3a+0b+8c	16=4a+2b+10c=5a+1b+10c=5a+2b+9c
=3a+1b+7c=3a+2b+6c	17=4a+2b+11c=5a+2b+10c
12=3a+1b+8c=3a+2b+7c=4a+0b+8c	18=5a+2b+11c
=4a+1b+7c	19=5a+2b+12c

Table 36. Conclusive series of stages in the ontogeny of midrib of *Gr. funalis* f. *longipila* BOUL.

7=2a+0b+5c	12=2a+2b+8c=2a+3b+7c=2a+4b+6c
8=2a+0b+6c=2a+1b+5c	13=2a+3b+8c=2a+4b+7c=2a+5b+6c
9=2a+0b+7c=2a+1b+6c=2a+2b+5c	14=2a+4b+8c=2a+5b+7c
10=2a+0b+8c=2a+1b+7c=2a+2b+6c	15=2a+5b+8c=2a+6b+7c
=2a+3b+5c	16=2a+6b+8c
11=2a+1b+8c=2a+2b+7c=2a+3b+6c	

Table 37. Conclusive series of stages in the ontogeny of midrib of *Gr. hartmanii* SCHIMP.

7=2a+0b+5c	13=2a+2b+9c
8=2a+0b+6c	14=2a+2b+10c
9=2a+0b+7c	15=3a+2b+10c
10=2a+1b+7c	16=3a+2b+11c
11=2a+1b+8c	17=3a+3b+11c
12=2a+1b+9c	18=3a+3b+12c

19=4a+3b+12c	29=4a+10b+15c
20=4a+3b+13c	30=4a+11b+15c
21=4a+4b+13c	31=4a+11b+16c
22=4a+5b+13c	32=4a+12b+16c
23=4a+5b+14c	33=4a+13b+16c
24=4a+6b+14c	34=4a+14b+16c
25=4a+7b+14c	35=4a+15b+16c
26=4a+8b+14c	36=4a+16b+16c
27=4a+9b+14c	37=4a+17b+16c
28=4a+10b+14c	38=4a+18b+16c

Table 38. Conclusive series of stages in the ontogeny of midrib of *Gr. incurva* SCHWAEGR.

7=2a+0b+5c	18=2a+5b+11c=2a+6b+10c=2a+7b+9c
8=2a+1b+5c=2a+0b+6c	19=2a+6b+11c=2a+7b+10c
9=2a+1b+6c=2a+2b+5c	20=2a+7b+11c=2a+8b+10c
10=2a+2b+6c	21=2a+7b+12c=2a+8b+11c=2a+9b+10c
11=2a+2b+7c	22=2a+8b+12c=2a+9b+11c=2a+10b+10c
12=2a+3b+7c	23=2a+10b+11c=2a+9b+12c
13=2a+3b+8c	24=2a+10b+12c
14=2a+3b+9c=2a+4b+8c	25=2a+10b+13c=2a+11b+12c
15=2a+4b+9c=2a+5b+8c	26=2a+11b+13c
16=2a+4b+10c=2a+5b+9c	27=2a+11b+14c
17=2a+4b+11c=2a+5b+10c=2a+6b+9c	28=2a+11b+15c

Table 39. Conclusive series of stages in the ontogeny of midrib of *Gr. laevigata* (BRID.) BRID.

7=2a+0b+5c	26=4a+11b+11c=5a+10b+11c=6a+9b+11c =6a+10b+10c=7a+8b+11c=8a+7b+11c
8=2a+0b+6c	27=5a+11b+11c=6a+10b+11c=7a+8b+12c =8a+8b+11c
9=2a+1b+6c	28=5a+12b+11c=6a+11b+11c=7a+9b+12c =8a+8b+12c=8a+9b+11c
10=2a+1b+7c=2a+2b+6c	29=6a+11b+12c=7a+10b+12c=6a+12b+11c =8a+7b+14c=8a+8b+13c=8a+9b+12c
11=2a+2b+7c=2a+3b+6c=3a+2b+6c	30=6a+12b+12c=7a+11b+12c=8a+8b+14c =8a+9b+13c=8a+10b+12c
12=2a+3b+7c=3a+3b+6c	31=6a+12b+13c=7a+11b+13c=7a+12b+12c =8a+10b+13c
13=2a+3b+8c=3a+3b+7c	32=7a+12b+13c=8a+11b+13c
14=3a+3b+8c	33=7a+13b+13c=8a+11b+14c
15=3a+4b+8c	34=8a+11b+15c
16=3a+5b+8c=4a+4b+8c	35=8a+12b+15c
17=3a+6b+8c=4a+4b+9c	36=9a+12b+15c
18=4a+6b+8c	37=9a+12b+16c
19=4a+7b+8c	38=9a+13b+16c
20=4a+7b+9c=4a+8b+8c=5a+7b+8c	39=9a+13b+17c
21=4a+8b+9c=5a+7b+9c=6a+6b+9c	40=9a+13b+18c
22=4a+8b+10c=5a+8b+9c=6a+7b+9c	
23=4a+9b+10c=5a+9b+9c=6a+7b+10c =5a+8b+10c	
24=4a+10b+10c=5a+10b+9c=5a+8b+11c =5a+9b+10c=5a+7b+11c=6a+8b+10c	
25=4a+10b+11c=5a+10b+10c=6a+8b+11c =6a+9b+10c=7a+8b+10c=7a+7b+11c	

Table 40. Conclusive series of stages in the ontogeny of midrib of *Gr. maritima* TURN.

7=2a+1b+4c
8=2a+2b+4c
9=2a+2b+5c=2a+3b+4c
10=2a+2b+6c=2a+3b+5c
11=3a+2b+6c=3a+3b+5c
12=3a+3b+6c=4a+2b+6c
13=4a+2b+7c=3a+3b+7c
14=3a+4b+7c=4a+2b+8c=4a+3b+7c
15=3a+4b+8c=4a+4b+7c=4a+3b+8c
=5a+3b+7c
16=3a+5b+8c=4a+5b+7c=5a+3b+8c
17=3a+5b+9c=4a+5b+8c=4a+6b+7c
=5a+4b+8c=5a+5b+7c
18=4a+5b+9c=4a+6b+8c=5a+5b+8c
19=4a+5b+10c=4a+6b+9c=4a+7b+8c
=5a+6b+8c
20=4a+7b+9c=5a+5b+10c=5a+6b+9c
=5a+7b+8c=6a+6b+8c=4a+6b+10c
21=4a+7b+10c=4a+8b+9c=5a+6b+10c
=5a+7b+9c=6a+6b+9c=6a+7b+8c
22=4a+8b+10c=5a+7b+10c=6a+7b+9c
=6a+6b+8c
23=4a+8b+11c=5a+8b+10c=6a+8b+8c
24=4a+9b+11c=5a+9b+10c=6a+9b+9c
25=5a+9b+11c=5a+10b+10c=6a+9b+10c
26=5a+10b+11c=6a+9b+11c=6a+10b+10c
27=6a+10b+11c=6a+11b+10c
28=6a+10b+12c=6a+11b+11c=6a+12b+10c
29=6a+11b+12c=6a+12b+11c=7a+10b+12c
=7a+12b+10c
30=6a+13b+11c=7a+11b+12c=7a+12b+11c
=6a+12b+12c
31=6a+14b+11c=6a+13b+12c=7a+12b+12c
=7a+13b+11c
32=6a+14b+12c=7a+13b+12c
33=6a+15b+12c=7a+13b+13c=7a+14b+12c
34=6a+16b+12c=7a+14b+13c=7a+15b+12c
35=6a+17b+12c=7a+15b+13c=7a+16b+12c
36=6a+18b+12c=7a+16b+13c=7a+17b+12c
37=6a+18b+13c=6a+19b+12c=7a+18b+12c
=7a+17b+13c=8a+16b+13c
38=6a+20b+12c=7a+19b+12c=7a+18b+13c
=8a+17b+13c
39=6a+20b+13c=7a+20b+12c=7a+19b+13c
=8a+18b+13c
40=6a+21b+13c=7a+20b+13c=8a+18b+14c
=8a+19b+13c
41=7a+21b+13c=8a+19b+14c
42=7a+22b+13c=8a+20b+14c
43=7a+22b+14c=8a+21b+14c
44=8a+22b+14c
45=8a+23b+14c
46=8a+24b+14c
47=8a+25b+14c
48=8a+25b+15c
49=8a+26b+15c
50=8a+27b+15c
51=9a+27b+15c
52=9a+28b+15c
53=9a+29b+15c
54=9a+30b+15c
55=9a+31b+15c
56=9a+32b+15c
57=9a+33b+15c
58=9a+34b+15c
59=9a+35b+15c=10a+34b+15c
60=9a+36b+15c=10a+35b+15c
61=10a+36b+15c
62=10a+37b+15c
63=10a+38b+15c
64=10a+39b+15c
65=10a+40b+15c
66=10a+40b+16c
67=10a+41b+16c
68=10a+42b+16c
69=10a+43b+16c
70=10a+44b+16c
71=10a+45b+16c
72=10a+46b+16c
73=10a+46b+17c
74=10a+47b+17c
75=10a+47b+18c
76=10a+48b+18c
77=10a+49b+18c
78=10a+50b+18c
79=10a+51b+18c
80=10a+52b+18c
81=11a+52b+18c
82=11a+53b+18c
83=11a+54b+18c

Table 41. Conclusive series of stages in the ontogeny of midrib of *Gr. mollis* B. S. G.

7=2a+1b+4c
8=2a+2b+4c
9=2a+3b+4c
10=2a+4b+4c
11=2a+4b+5c=3a+4b+4c
12=3a+4b+5c
13=3a+4b+6c=4a+4b+5c
14=4a+4b+6c=4a+5b+5c
15=4a+5b+6c
16=4a+6b+6c
17=4a+6b+7c=4a+7b+6c
18=4a+6b+8c=4a+7b+7c

19=4a+7b+8c	22=4a+10b+8c
20=4a+8b+8c	23=4a+11b+8c
21=4a+9b+8c	24=4a+12b+8c

Table 42. Conclusive series of stages in the ontogeny of midrib of *Gr. orbicularis* var. *persica* SCHIFFNER.

7=2a+0b+5c=2a+1b+4c	13=2a+4b+7c=2a+6b+5c
8=2a+1b+5c=2a+2b+4c	14=2a+5b+7c=2a+6b+6c=2a+7b+5c
9=2a+2b+5c=2a+3b+4c	15=2a+6b+7c=2a+7b+6c=2a+8b+5c
10=2a+2b+6c=2a+3b+5c	16=2a+7b+7c=2a+8b+6c
11=2a+4b+5c=2a+3b+6c	17=2a+8b+7c
12=2a+3b+7c=2a+4b+6c=2a+5b+5c	

Table 43. Conclusive series of stages in the ontogeny of midrib of *Gr. ovalis* (HEDW.) LINDB.

7=2a+0b+5c	30=6a+11b+13c
8=2a+0b+6c	31=6a+11b+14c
9=2a+0b+7c	32=6a+12b+14c
10=3a+0b+7c	33=6a+13b+14c
11=3a+0b+8c	34=6a+13b+15c
12=4a+0b+8c	35=6a+14b+15c
13=4a+0b+9c	36=6a+15b+15c
14=4a+1b+9c	37=6a+16b+15c
15=4a+2b+9c	38=6a+17b+15c
16=4a+3b+9c	39=7a+17b+15c
17=4a+4b+9c	40=7a+18b+15c
18=4a+5b+9c	41=7a+19b+15c
19=4a+5b+10c	42=7a+20b+15c
20=4a+6b+10c	43=7a+21b+15c
21=4a+6b+11c	44=7a+22b+15c
22=4a+7b+11c	45=7a+22b+16c
23=4a+7b+12c	46=7a+23b+16c
24=4a+8b+12c=5a+7b+12c	47=7a+24b+16c
25=5a+8b+12c	48=7a+25b+16c
26=5a+9b+12c	49=7a+25b+17c
27=5a+9b+13c	50=7a+25b+18c
28=6a+9b+13c	51=7a+26b+18c
29=6a+10b+13c	

Table 44. Conclusive series of stages in the ontogeny of midrib of *Gr. patens* (HEDW.) B. S. G.

7=2a+0b+5c	18=4a+2b+12c
8=2a+0b+6c	19=4a+3b+12c
9=2a+0b+7c	20=4a+3b+13c
10=2a+0b+8c	21=4a+4b+13c
11=3a+0b+8c	22=4a+4b+14c
12=4a+0b+8c	23=4a+4b+15c
13=4a+0b+9c	24=4a+5b+15c
14=4a+0b+10c	25=4a+5b+16c
15=4a+1b+10c	26=4a+6b+16c
16=4a+2b+10c	27=4a+7b+16c
17=4a+2b+11c	28=4a+8b+16c

29=4a+ 9b+16c
30=4a+10b+16c
31=4a+11b+16c
32=4a+11b+17c=4a+12b+16c
33=4a+11b+18c=4a+13b+16c
34=4a+14b+16c=5a+11b+18c
35=4a+15b+16c=5a+12b+18c
36=4a+16b+16c=5a+13b+18c
37=4a+17b+16c=5a+14b+18c
38=4a+18b+16c=5a+15b+18c=5a+17b+16c
39=4a+19b+16c=5a+16b+18c=5a+17b+17c
40=4a+20b+16c=5a+17b+18c
41=4a+21b+16c=5a+18b+18c
42=4a+22b+16c=5a+19b+18c
43=4a+23b+16c=5a+20b+18c
44=4a+24b+16c=4a+23b+17c=5a+21b+18c
45=4a+25b+16c=4a+23b+18c=5a+22b+18c
46=4a+26b+16c=4a+24b+18c=5a+23b+18c
47=4a+27b+16c=4a+25b+18c=5a+24b+18c
48=4a+28b+16c=4a+26b+18c=5a+25b+18c
49=4a+29b+16c=4a+27b+18c=5a+26b+18c
50=4a+29b+17c=4a+28b+18c=5a+27b+18c
51=4a+30b+17c=4a+29b+18c=5a+28b+18c
52=4a+31b+17c=4a+30b+18c=5a+29b+18c
53=4a+31b+18c=5a+30b+18c
54=4a+32b+18c=5a+30b+19c
55=4a+32b+19c=5a+31b+19c
56=4a+32b+20c=5a+31b+20c
57=5a+32b+20c=5a+31b+21c
58=5a+32b+21c=5a+33b+20c
59=5a+33b+21c=5a+34b+20c
60=5a+34b+21c
61=5a+35b+21c
62=5a+36b+21c
63=5a+37b+21c
64=5a+38b+21c
65=5a+39b+21c
66=5a+40b+21c
67=5a+40b+22c
68=5a+41b+22c
69=5a+42b+22c
70=5a+43b+22c
71=5a+44b+22c
72=5a+45b+22c
73=5a+46b+22c
74=5a+47b+22c
75=5a+48b+22c
76=5a+49b+22c
77=5a+50b+22c
78=5a+51b+22c=6a+50b+22c
79=6a+51b+22c
80=6a+52b+22c
81=6a+52b+23c
82=6a+53b+23c
83=6a+54b+23c
84=6a+55b+23c
85=6a+56b+23c
86=6a+57b+23c
87=6a+58b+23c=7a+57b+23c
88=6a+59b+23c=7a+58b+23c
89=6a+60b+23c=7a+58b+24c
90=6a+60b+24c=7a+59b+24c
91=6a+61b+24c=7a+60b+24c
92=6a+62b+24c=7a+61b+24c
93=6a+63b+24c=7a+62b+24c
94=7a+63b+24c
95=7a+64b+24c
96=7a+65b+24c
97=7a+66b+24c
98=7a+66b+25c
99=7a+67b+25c
100=7a+68b+25c
101=7a+69b+25c
102=7a+70b+25c
103=7a+71b+25c

Table 45. Conclusive series of stages in the ontogeny of midrib of *Gr. pilifera* P. BEAUV.

7=2a+0b+5c
8=2a+0b+6c
9=2a+0b+7c
10=2a+1b+7c
11=2a+2b+7c
12=2a+2b+8c
13=2a+2b+9c=2a+3b+8c
14=2a+3b+9c
15=2a+3b+10c
16=2a+4b+10c
17=2a+4b+11c
18=2a+4b+12c
19=2a+5b+12c
20=2a+5b+12c

Table 46. Conclusive series of stages in the ontogeny of midrib of *Gr. plagiopodia* HEDW.

7=2a+0b+5c=2a+1b+4c=2a+2b+3c
8=2a+1b+5c=2a+2b+4c=2a+3b+3c
9=2a+1b+6c=2a+2b+5c=2a+3b+4c
=2a+4b+3c
10=2a+2b+6c=2a+3b+5c=2a+4b+4c
11=2a+3b+6c=2a+4b+5c=2a+5b+4c
12=2a+4b+6c=2a+5b+5c
13=2a+5b+6c=2a+6b+5c

14=2a+5b+7c=2a+6b+6c 15=2a+5b+8c=2a+6b+7c=2a+7b+6c	16=2a+6b+8c=2a+7b+7c=2a+8b+6c

Table 47. Conclusive series of stages in the ontogeny of midrib of *Gr. pulvinata* (HEDW.) SM.

7=2a+1b+4c 8=2a+2b+4c 9=2a+2b+5c=2a+3b+4c 10=2a+3b+5c=2a+4b+4c 11=2a+3b+6c=2a+4b+5c	12=2a+4b+6c=2a+5b+5c 13=2a+5b+6c 14=2a+6b+6c 15=2a+7b+6c 16=2a+8b+6c

Table 48. Conclusive series of stages in the ontogeny of midrib of *Gr. pulvinata* var. *africana* (HEDW.) HOOK. f. et WILS.

7=2a+1b+4c 8=2a+1b+5c=2a+2b+4c 9=2a+2b+5c=2a+3b+4c 10=2a+3b+5c=2a+4b+4c 11=2a+4b+5c=2a+5b+4c 12=2a+4b+6c=2a+5b+5c 13=2a+5b+6c=2a+6b+5c 14=2a+5b+7c=2a+6b+6c 15=2a+6b+7c=2a+7b+6c	16=2a+7b+7c=2a+8b+6c 17=2a+7b+8c=2a+8b+7c=2a+9b+6c 18=2a+8b+8c=2a+9b+7c=2a+10b+ 6c 19=2a+9b+8c=2a+10b+7c 20=2a+10b+8c 21=2a+10b+9c 22=2a+10b+10c 23=2a+10b+11c

Table 49. Conclusive series of stages in the ontogeny of midrib of *Gr. teretinervis* LIMPR.

7=2a+1b+4c 8=2a+2b+4c 9=2a+3b+4c 10=2a+4b+4c 11=2a+5b+4c 12=2a+5b+5c=2a+6b+4c 13=2a+5b+6c=2a+6b+5c=2a+7b+4c 14=2a+7b+5c=3a+5b+6c=3a+6b+5c 15=2a+8b+5c=3a+6b+6c=3a+7b+5c	16=2a+8b+6c=3a+7b+6c 17=3a+7b+7c=3a+8b+6c=4a+7b+6c 18=3a+8b+7c=4a+7b+7c=4a+8b+6c 19=4a+8b+7c 20=4a+8b+8c 21=4a+9b+8c 22=4a+10b+8c 23=4a+11b+8c

Table 50. Conclusive series of stages in the ontogeny of midrib of *Gr. trichophylla* ssp. *lisae* (DE NOT.) BOUL.

7=2a+0b+5c=2a+1b+4c 8=2a+0b+6c=2a+1b+5c 9=2a+1b+6c=2a+2b+5c 10=2a+1b+7c=2a+2b+6c=2a+3b+5c 11=2a+2b+7c=2a+3b+6c 12=2a+3b+7c=2a+4b+6c 13=2a+4b+7c=2a+5b+6c 14=2a+5b+7c=2a+6b+6c	15=2a+6b+7c=2a+7b+6c 16=2a+7b+7c=2a+8b+6c 17=2a+8b+7c=2a+9b+6c 18=2a+9b+7c 19=2a+10b+7c 20=2a+11b+7c 21=2a+11b+8c

Table 51. Conclusive series of stages in the ontogeny of midrib of *Gr. trichophylla* f. *robusta* PODP.

7=2a+0b+5c	34=4a+14b+16c=5a+14b+15c
8=2a+0b+6c	35=4a+15b+16c=5a+14b+16c=5a+15b+15c
9=2a+0b+7c	36=4a+16b+16c=5a+16b+15c
10=3a+0b+7c	37=4a+17b+16c=5a+16b+16c=6a+16b+15c
11=3a+0b+8c	38=5a+17b+16c=6a+16b+16c
12=3a+0b+9c	39=5a+18b+16c=6a+17b+16c
13=4a+0b+9c	40=5a+19b+16c=6a+18b+16c
14=4a+0b+10c	41=5a+20b+16c=6a+18b+17c=6a+19b+16c
15=4a+1b+10c	42=5a+21b+16c=6a+19b+17c
16=4a+2b+10c	43=5a+22b+16c=6a+20b+17c
17=4a+3b+10c	44=5a+23b+16c=6a+21b+17c
18=4a+4b+10c	45=5a+23b+17c=6a+22b+17c
19=4a+5b+10c	46=5a+23b+18c=6a+22b+18c
20=4a+5b+11c	47=5a+24b+18c=6a+23b+18c
21=4a+6b+11c	48=5a+25b+18c=6a+24b+18c
22=4a+6b+12c	49=6a+25b+18c
23=4a+6b+13c	50=6a+26b+18c
24=4a+7b+13c	51=6a+27b+18c
25=4a+8b+13c	52=6a+28b+18c
26=4a+9b+13c	53=6a+29b+18c
27=4a+10b+13c	54=6a+29b+19c
28=4a+11b+13c	55=6a+30b+19c
29=4a+12b+13c	56=6a+31b+19c
30=4a+12b+14c	57=6a+32b+19c
31=4a+12b+15c=5a+12b+14c	58=6a+32b+20c
32=4a+13b+15c=5a+13b+14c	59=6a+33b+20c
33=4a+14b+15c=5a+13b+15c=6a+13b+14c	

Table 52. Conclusive series of stages in the ontogeny of midrib of *Gr. torquata* GREV.

7=2a+1b+4c	11=2a+2b+7c=2a+3b+6c
8=2a+2b+4c=2a+1b+5c	12=2a+3b+7c
9=2a+1b+6c=2a+2b+5c	13=2a+4b+7c
10=2a+2b+6c=2a+3b+5c	14=2a+5b+7c

Table 53. Conclusive series of stages in the ontogeny of midrib of *Gr. brunnescens* f. *epilosa* (SCHIFFN.) PAR.

7=2a+0b+5c	19=2a+7b+10c=2a+8b+9c
8=2a+1b+5c	20=2a+7b+11c=2a+8b+10c=2a+9b+9c
9=2a+1b+6c	21=2a+8b+11c=2a+9b+10c
10=2a+2b+6c	22=2a+9b+11c=2a+10b+10c
11=2a+2b+7c	23=2a+10b+11c
12=2a+2b+8c=2a+3b+7c	24=2a+10b+12c=3a+9b+12c
13=2a+2b+9c=2a+3b+8c	25=3a+9b+13c=3a+10b+12c
14=2a+3b+9c=2a+4b+8c	26=3a+11b+12c
15=2a+4b+9c=2a+5b+8c	27=3a+12b+12c
16=2a+5b+9c=2a+6b+8c	28=3a+12b+13c
17=2a+6b+9c=2a+7b+8c	29=3a+13b+13c
18=2a+7b+9c=2a+8b+8c	

Table 54. Conclusive series of stages in the ontogeny of midrib of *Gr. brunnescens* f. *humilior* VILHL.

7=2a+0b+5c=2a+1b+4c	16=2a+6b+8c=2a+7b+7c
8=2a+1b+5c=2a+2b+4c	17=2a+7b+8c
9=2a+2b+5c	18=2a+8b+8c=3a+7b+8c
10=2a+2b+6c=2a+3b+5c	19=2a+9b+8c=3a+8b+8c
11=2a+2b+7c=2a+3b+6c=2a+4b+5c	20=2a+9b+9c=3a+9b+8c
12=2a+3b+7c=2a+4b+6c	21=3a+9b+9c=3a+10b+8c=3a+8b+10c
13=2a+4b+7c=2a+5b+6c	22=3a+9b+10c=3a+10b+9c
14=2a+4b+8c=2a+5b+7c=2a+6b+6c	23=3a+10b+10c
15=2a+5b+8c=2a+6b+7c	

Table 55. Conclusive series of stages in the ontogeny of midrib of *Gr. gracilis* SCHWAEGR.

7=2a+0b+5c	14=2a+3b+9c=2a+4b+8c
8=2a+0b+6c=2a+1b+5c	15=2a+4b+9c=2a+5b+8c
9=2a+1b+6c=2a+2b+5c	16=2a+5b+9c
10=2a+1b+7c=2a+2b+6c	17=2a+6b+9c
11=2a+2b+7c=2a+3b+6c	18=2a+7b+9c
12=2a+3b+7c=2a+4b+6c	19=2a+8b+9c
13=2a+3b+8c=2a+4b+7c	

Table 56. Conclusive series of stages in the ontogeny of midrib of *Gr. gracilis* f. *subepilosa* PILOUS.

7=2a+0b+5c=2a+1b+4c	13=2a+3b+8c=2a+4b+7c=2a+5b+6c
8=2a+1b+5c=2a+2b+4c	14=2a+4b+8c=2a+5b+7c
9=2a+1b+6c=2a+2b+5c=2a+3b+4c	15=2a+4b+9c=2a+5b+8c
10=2a+2b+6c=2a+3b+5c	16=2a+5b+9c=2a+6b+8c
11=2a+2b+7c=2a+3b+6c=2a+4b+5c	17=2a+6b+9c=2a+7b+8c
12=2a+3b+7c=2a+4b+6c	18=2a+7b+9c

Table 57. Conclusive series of stages in the ontogeny of midrib of *Gr. gracilis* f. *tenuis* VILHL.

7=2a+0b+5c	18=2a+6b+10c=2a+7b+9c=2a+8b+8c
8=2a+0b+6c=2a+1b+5c	19=2a+7b+10c=2a+8b+9c=2a+9b+8c
9=2a+1b+6c=2a+2b+5c	20=2a+7b+11c=2a+8b+10c=2a+9b+9c
10=2a+2b+6c	21=2a+8b+11c=2a+9b+10c=2a+10b+9c
11=2a+2b+7c=2a+3b+6c	22=2a+9b+11c=2a+10b+10c
12=2a+3b+7c=2a+4b+6c	23=2a+9b+12c=2a+10b+11c=2a+11b+10c
13=2a+3b+8c=2a+4b+7c	24=2a+10b+12c=2a+12b+10c
14=2a+3b+9c=2a+4b+8c	25=2a+11b+12c=2a+12b+11c=2a+13b+10c
15=2a+4b+9c=2a+5b+8c	26=2a+12b+12c=2a+13b+11c
16=2a+5b+9c=2a+6b+8c	27=2a+13b+12c
17=2a+6b+9c=2a+7b+8c	

From these tables, I see that the number of cells is best fixed at the **a-part** of the three parts with the consequence that the consideration of the number of cells at the **a-part** is of primary importance. Then, by way of comparative morphology let

Table 58. Affinity in ontogeny of the midrib among some species.

T	*ovalis*	*hartmanii*	*microtheca*	*apocarpa*	*donniana*	*rivularis*	*mollis*
	7+26+18	4+18+16	2+12+11	2+13+15	2+10+10	2+11+8	4+12+8
18	4+5+9	3+3+12	2+8+8 2+8+8	2+6+10 2+6+10	2+7+9 2+7+9	2+8+8	4+7+7
17	4+4+9	3+3+11	2+7+8	2+7+8=2+5+10=2+6+9 2+5+10	2+6+9	2+8+7	4+7+6
16	4+3+9	3+2+11	2+6+8	2+5+9=2+6+8 2+5+9	2+6+8 2+5+9	2+7+7	4+6+6
15	4+2+9	3+2+10	2+5+8	2+4+9=2+5+8 2+5+8	2+5+8 2+4+9	2+7+6 2+7+6	4+5+6
14	4+1+9	2+2+10 2+2+10	2+4+8	2+3+9=2+4+8=2+5+7=2+6+6 2+4+8	2+4+8 2+5+7	2+6+6	4+4+6
13	4+0+9	2+2+9	2+3+8	2+2+9=2+3+8=2+4+7=2+5+6 2+4+7	2+4+7	2+5+6	3+4+6
12	4+0+8	2+1+9	2+3+7 2+2+8	2+1+9=2+2+8=2+3+7=2+4+6 2+3+7	2+3+7 2+4+6	2+4+6	3+4+5 3+4+5
11	3+0+8	2+1+8	2+2+7	2+1+8=2+2+7=2+3+6=2+4+5 2+2+7	2+3+6 2+2+7	2+3+6 2+4+5	2+4+5
10	3+0+7 3+0+7	2+1+7	2+1+7	2+1+7=2+2+6=2+3+5=2+4+4 2+2+6	2+1+7 2+2+6	2+3+5	2+4+4
9	2+0+7	2+0+7	2+1+6	2+0+7=2+1+6=2+2+5=2+3+4 2+1+6	2+2+5 2+1+6	2+3+4	2+3+4
8	2+0+6	2+0+6	2+1+5	2+0+6=2+1+5=2+2+4 2+1+5	2+1+5	2+2+4	2+2+4
7	2+0+5	2+0+5	2+0+5	2+0+5=2+1+4 2+0+5	2+0+5	2+1+4	2+1+4

me give an illustration from some species, I show in the Table 58 how to compare the processes of ontogeny of the midrib on the basis of the cell number of the **a-part**. By such a way I tryed to compare the processes of ontogeny of the midrib of each species; that is, on the basis of the cell number of the **a-part**, I obtained the relationship shown in Table 59. Table 59 shows the ralationship of five types as classified on the basis of affinity shown in the ontogeny of the midrib especially in the cell formation of the **a-part**. In the early stage of ontogeny of the midrib, that is, in the stage of **T=13**, the midrib of some species has two cells of the **a-part**, others have two or three cells of the **a-part** (**D type**), or have three cells (**E type**). The ontogeny of midrib whose cell number of the **a-part** is two cells in the stage of **T=13**, is divided into three types, **A**, **B** and **C** which are defined on the basis of the cell number of **a-part** in stages of **T=14** and **15**.

Table 59. The relationship of five types as classified on the basis of affinity in ontogeny of the midrib (cell number of the a-part as criterion).

T=13	T=14	T=15	Final	0 < T < 20	20 < T < 40	40 < T < 60	80 < T < 110	Type
2a	2a	2a	2a	*alpicola* *calvescens* *gracilis* *longipila* *persica* *plagiopodia* *pulvinata* *subepilosa* *torquata*	*africana* *agassizii* *apocarpa* *atrofusca* *conferta* *decalvata* *donniana* *elatior* *funalis* *incurva* *lisae* *microtheca* *pilifera* *rivularis* *tenuis*	*anomala*		A
			3a		*epilosa* *humilior*			
		2–3a	11a				*arizonae*	B
		3a	4a		*hartmanii*			
	2–3a		4a		*teretinervis*			C
			6a		*tenerrima*			
2–3a			4a		*mollis*			D
			5a		*acutifolia*			
			9a			*laevigata*		
			11a		*anodon*			
3a	4a		6a			*robusta*		E
			7a			*ovalis*	*patens*	
	4–6a		6a		*cratericola*			
			7a			*decipiens*		
			11a				*maritima*	

Furthermore, I tryed to compare the processes of ontogeny of the midrib of each species on the basis of cell numbers of the **a-**, **b-**, and **c-part**, and I obtained Fig 2. As seen in Fig 2, the structures of the midrib of fourty-one species are first divided into three, **I**, **II**, and **III-branch**, on the basis of the mode of ontogeny in the stage of **T=13**. According to the mode in the stage of **T=14** the midribs of **I-branch** are divided into **I-A** and **I-B**; **II-branch** into **II-A** and **II-B**. Thus the 41 species are divided into five general groups, **I-A**, **I-B**, **II-A**, **II-B**, and **III**. Besides, in the stage of **T=15** the midribs of **I-A** are further divided into **I-A-1** and **I-A-2**; **II-B** into **II-B-1** and **II-B-2**. **I-A-1** are finally divided into four groups; **II-B-2** are divided into two. As mentioned above, values of **a**, **b**, **c** and **T** in the formula **a+b+c=T** at each stage are not fixed and have a certain amount of variation. For this reason it is hard to describe conclusively with a line the affinity regarding the midrib. The relationship represented by dotted lines shows that it is subject to variation.

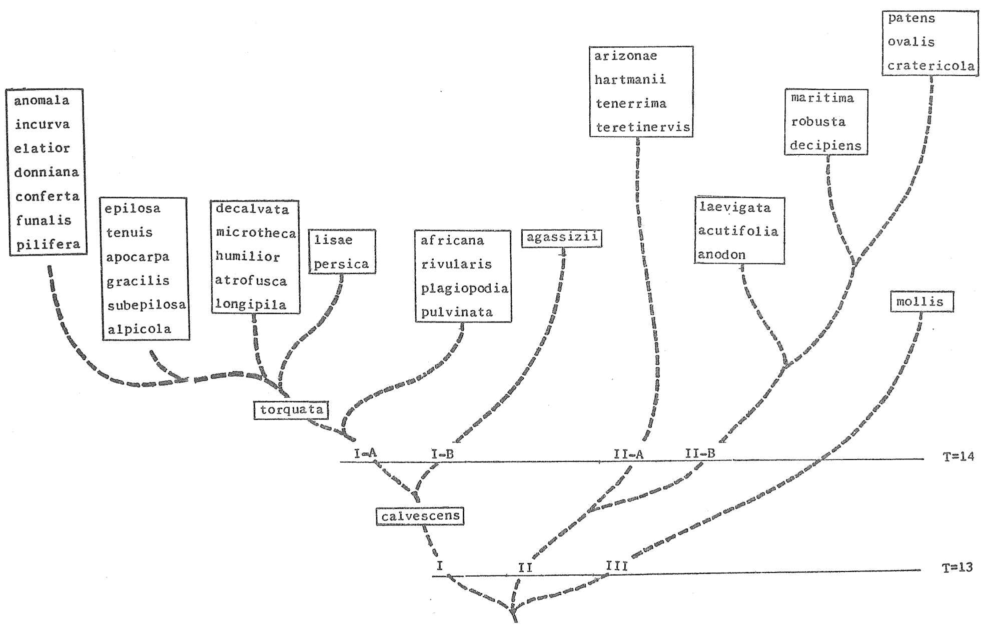


Fig 2. The relationship of fourty-one species of *Grimmia* as classified on the basis of affinity in ontogeny of the midrib.

(2) Morphological Differentiation of the Midrib

As to the inner structure of the midrib, the numerical differentiations of the cells both in the **process of ontogeny** and in the **final structure** have already been mentioned. Morphological differentiation of tissue also shows some differences from species to species. Then, I observed the inner structures of the midribs and made a sketch of it (Plate I-XXI). On the basis of affinity showed in morphological differentiation I can classify the inner structure of the midrib into four groups (Table 60).

Table 60. Four types of the inner structures of the midrib.

Types of midrib	Species		
A group The distinction between a-, c-part and b-part is not clear	*alpicola* *anomala* *atrofusca* *calvescens* *conferta* *cratericola*	*decalvata* *epilosa* *gracilis* *humilior* *incurva* *longipila*	*pilifera* *rivularis* *subepilosa* *tenuis* *torquata*
B group The distinction between a-, c-part and b-part is slightly clear	*acutifolia* *africana* *agassizii* *anodon* *apocarpa* *donniana*	*elatior* *funalis* *hartmanii* *lisae* *microtheca* *mollis*	*persica* *plagiopodia* *pulvinata* *tenerrima* *teretinervis*
C group The distinction between a-, c-part and b-part is clear, without guide cells	*arizonae* *decipiens* *laevigata* *ovalis* *patens*	*robusta*	
D group The distinction between a-, c-part and b-part is clear, with guide cells	*maritima*		

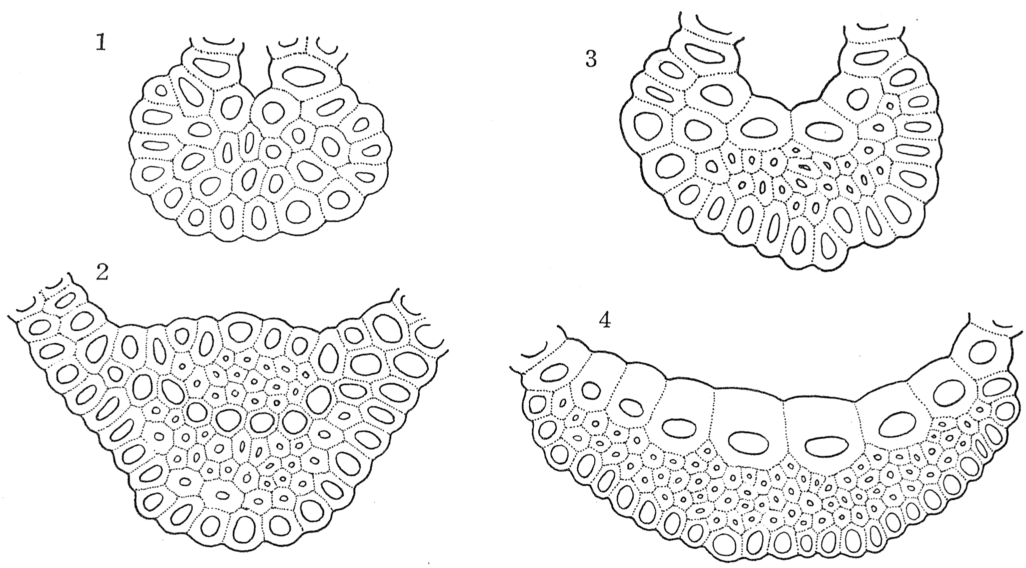


Fig 3. Four types of the inner structure of the midrib.
1: The distinction between a-, c-part and b-part is not clear (A group), *Gr. incurva* SCHWAEG.
2: The distinction between a-, c-part and b-part is clear, with guide cells (D group), *Gr. maritima* TURN.
3: The distinction between a-, c-part and b-part is slightly clear (B group), *Gr. hartmanii* SCHIMP.
4: The distinction between a-, c-part and b-part is clear, without guide cells (C group), *Gr. patens* (HEDW.) B. S. G.

The type of the midrib named A **group** has almost uniform cells in the three parts as shown in *Gr. incurva* (Fig 3-1). In **B group**, the distinction between **a-** and **c-part** is not clear but distinctions between **a-** and **b-part**, and between **c-** and **b-part** are somewhat clear. As shown in Fig 3-3, *Gr. hartmanii* is belonging to the **B group**. The midribs which belong to **C group**, have clear distinctions between **a-** and **b-part**, and between **c-** and **b-part**, but have not the guide cells in the **b-part**. As shown in Fig 3-4, *Gr. patens* is included in the **C group**. In **D group**, the distinctions between **a-** and **b-part**, and between **c-** and **b-part** are clear and guide cells become differentiated from the tissue of the **b-part** as shown in *Gr. maritima* of Fig 3-2.

(3) Numerical and Morphological Characteristics of the Midrib

The inner structure of the midrib is by their origin divided into three parts as mentioned before. In some species, the three parts are quite distinct, each having its specificity, but in some others the three parts are quite indistinguishable. In view of these morphological differences, the midrib structures were divided into four groups. The differentiation in numerical characteristics has already been mentioned. Now the relationship of the cell number of the **a-part**, the total cell number of the midrib and the importance index with the morphological differentiations of the midrib was considered and its results are shown in Table 61. The **importance index** is obtained by the following formula: $\mathbf{I}=(\mathbf{a}\times 1)+(\mathbf{b}\times 0.5)+(\mathbf{c}\times 0.8)$, namely, the total cell

Table 61. Relationship between numerical and morphological characteristics of the midrib.

Numerical characteristics of midrib	Types of morphological characteristics of midrib			
	A group	**B group**	**C group**	**D group**
a Cell number of the a-part	Mean value 3.3	Mean value 4.5	Mean value 7.4	Mean value 7.3
	2a, 3a, 5a,	2a, 3a, 4a, 5a, 6a, 7a,	4a, 6a, 7a, 9a, 11a,	4a, 5a, 9a, 11a,
T The total number of the cells	Mean value 20	Mean value 28	Mean value 60	Mean value 65
	13, 14, 16, 17, 18, 19, 20, 22, 23, 24, 27, 28,	13, 16, 21, 23, 24, 25, 27, 28, 29, 30, 34, 35, 38, 48,	35, 39, 40, 48, 51, 59, 96, 103,	36, 59, 82, 84,
I Importance index*	Mean value 14	Mean value 17	Mean value 41	Mean value 40
	9, 10, 11, 12, 13, 14, 15, 16, 17, 18,	8, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25,	26, 29, 33, 34, 38, 62, 64,	23, 35, 49, 54,

*Importance index : $(a\times 1)+(b\times 0.5)+(c\times 0.8)$

number of the midrib is converted on the basis of degree of fixation of cell number of each part.

The table reveals: (1) First to be considered is the relationship between the cell number of the **a-part** and the morphological differentiation of the midrib structure. In the table, with A→D, **2a→11a** follows. Thus I know that as the morphological structure gradually tends towards differentiation, the cell number of the **a-part** tends to increase. (2) The relationship between the total cell number and the morphological differentiation is not so definite as that between the **a-part** and the morphological differentiation. It seems, however, the greater the morphological differentiation is, the larger the total cell number of the midrib generally is. (3) As for the importance index too, almost the same tendency is observed as in the case of the total cell number.

As a summary, I may say that species with greater morphological differentiations in the midrib possess a greater number of cells composing the **a-part**, a greater total cell number, and a larger importance index. The correlation is especially clear between the morphological differentiation and the cell number of the **a-part.**

2. Inner Structure of the Stem

The inner structures of the stem of Bryidae are generally divided into the following three parts: **Epidermal layer**, **cortical layer** and **central strand.** This is the case with the caulis, but not always so with the ramus. The cross section reveals

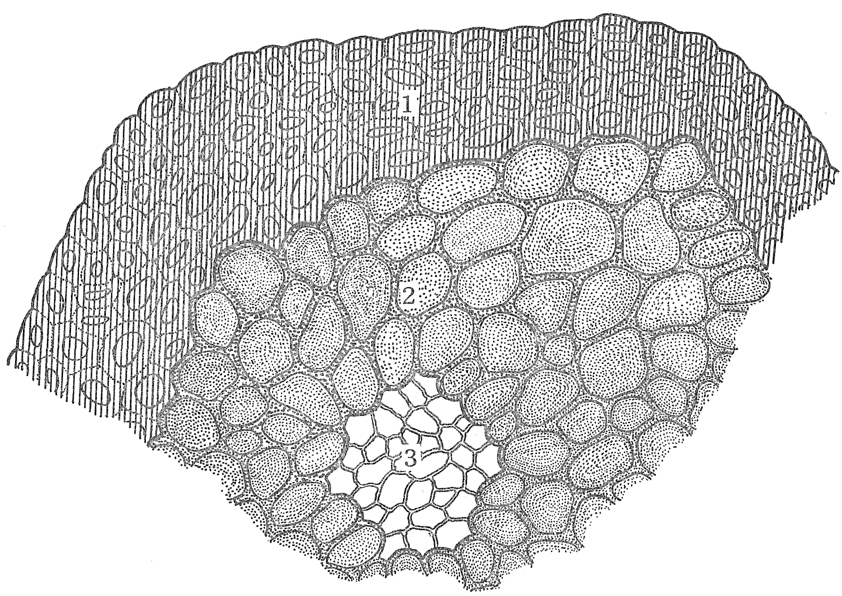
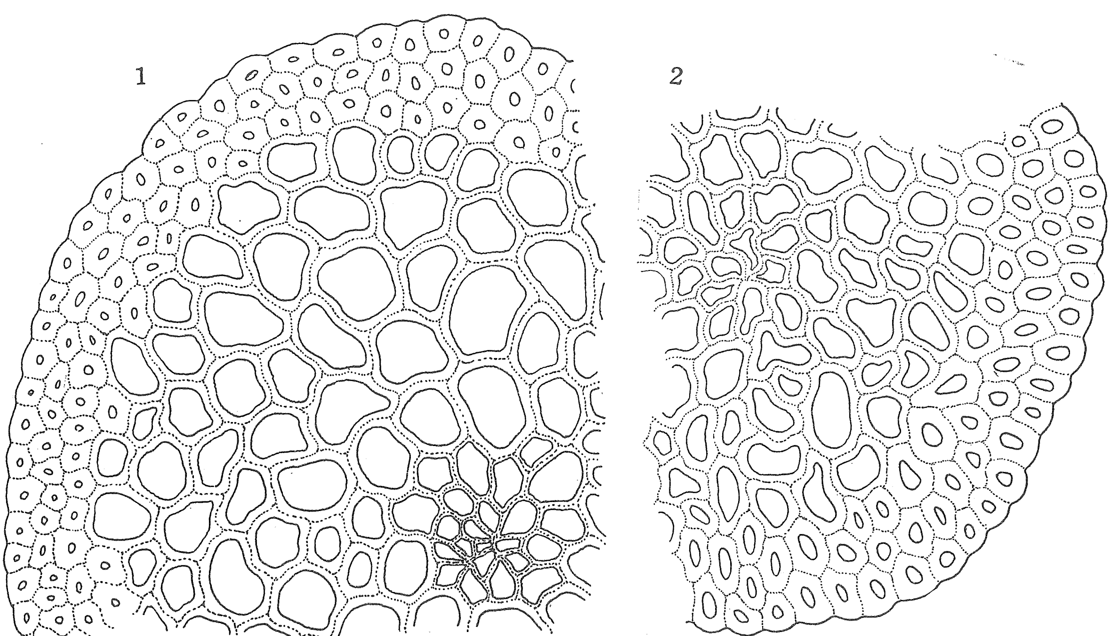


Fig 4. Three parts of the inner structure of the stem (*Gr. ovalis*).
1: epidermal layer (the hatched part).
2: cortical layer (the dotted part).
3: central strand (the blank part).

that the cells from either the epidermal layer, cortical layer or central strand are in some species distinguishable in shape but are not so in others. The **epidermal layer**, which is made up of one cell or several cells in width, has the most thickened cell-wall of the three parts as shown in No.1 of Fig 4. The **cortical layer** which is generally several cells in thickness, exists between the epidermal layer and central strand. The cell-wall of the cortical layer is slightly thickened and No. 2 in Fig 4 affords an instance of the cortical layer. As shown in No. 3 of Fig 4, the **central strand**, of which the cells have thin-walls and are linear, constitutes the central axis of the stem.

It is said that even in some species of subgenus *Schistidium*, the inner structure of the **fertile stem** is different from that of the **sterile stem**, that is, the central strand is present in the former but absent in the latter. In order to confirm this and also to ascertain the inner structure of the stem, fifty plants of *Gr. apccarpa* which belong to the subgenus *Schistidium* were collected and their stems both **sterile** and **fertile** were examined. As a result I found that the **sterile stem** and the **fertile stem** are not quite distinguishable. The structure shown in Fig 5-No. 2 is seen in



Ffg 5. Variation of the inner structures of the stem in *Gr. apocarpa* HEDW.

1: Fertile type (the distinction among the epidermal, cortical layer and central strand is clear).

2: Sterile type (the distinction between the epidemal and cortical layer is clear but that between the cortical layer and central strand is slight.).

both the **sterile stem** and the **ferile stem**, but the No.1 structure is only seen in the **fertile stem**. 100% of the **sterile stems** show the No.2 structure, whereas about 60% of the **fertile stems** show the No.2 structure and about 40% the No.1 structure. This means that stem with No.2 structure gradually changes into No.1 with fertility.

Now against the assertion that the central strand is absent in the **sterile stem**, I say the central strand is certainly present and visible though not quite distinct. Even in No.2 which is of the most obscure structure, I notice a group of smaller thin-walled cells at the center. In the fertile stem, this central portion is somewhat clearer and it becomes most clear and can be easily recognized as in No.1. Thus due to the presence of structures which are in the gradual process of shifting from No.2 to No.1, I may conclude that, even in No.2 where the strand is very obscure, the central strand is certainly present but quite indistinct when it is still in its earlier stages. Thus there are intermediary types between No.1 and No.2 making a continuous series of structure, but there are no intermediary types between No.1 and No.2 as to the thickness of the stem. From these observations, it was known that the central strand of the **sterile stem**, whether it is caulis or ramus, shows an indistinct structure of central strand and the stem itself is rather small as shown in No.2. The **fertile stem** has a distinct central strand, and is somewhat larger in thickness as shown in No.1.

Table 62. Four types of the inner structures of the stem.

Types of stem	Species		
a group The distinction among the epidermal, cortical layer and central strand is quite obscure	*alpicola* *conferta* *donniana* *mollis*		
b group The distinction between the epidermal and cortical is clear but the cortical and central strand is not	*acutifolia* *agassizii* *apocarpa* *decalvata* *elatior*	*epilosa* *gracilis* *humilior* *incurva* *microtheca*	*pilifera* *rivularis* *subepilosa* *tenerrima* *torquata*
c group The distinction among the epidermal, cortical and central strand is clear and the central strand is composed of less than 15 cells	*africana* *anodon* *anomala* *atrofusca* *calvescens* *funalis*	*hartmanii* *laevigata* *lisae* *longipila* *maritima*	*persica* *plagiopodia* *pulvinata* *tenuis* *teretinervis*
d group The distinction among the epidermal, cortical and central strand is clear and the central strand is composed of more than 15 cells	*arizonae* *cratericola* *decipiens* *ovalis* *patens*	*robusta*	

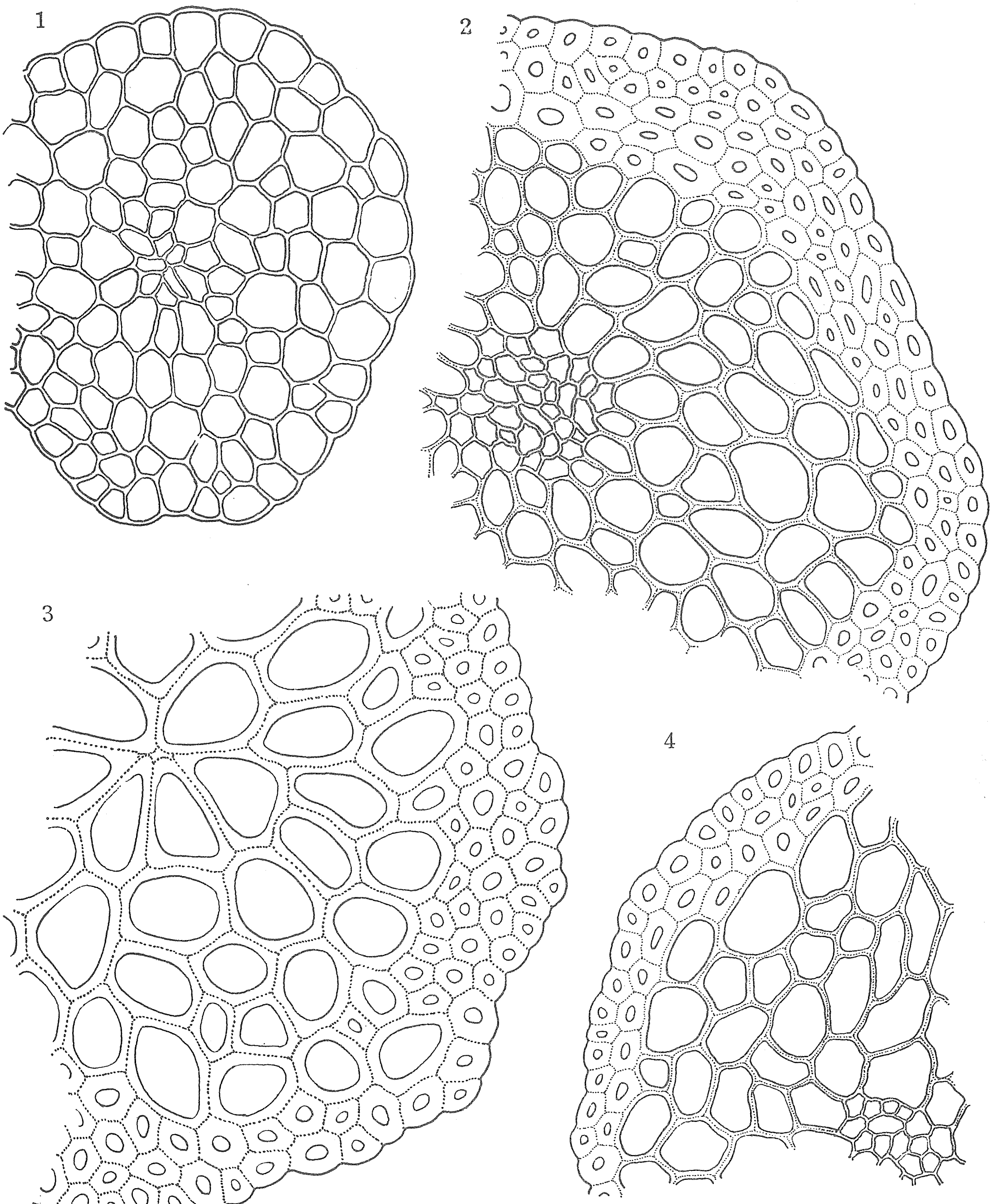


Fig 6. Four types of the inner structures of the stem.

1: The distinction among the epidermal, cortical layer and central strand is quite obscure (a group), *Gr. mollis* B. S. G.

2: The distinction among the epidermal, cortical layer and central strand is clear and the central strand is composed of more than fifteen cells (d group), *Gr. ovalis* (HEDW.) LINDB.

3: The distinction between the epidermal and cortical layer is clear but the cortical and central strand is not (b group), *Gr. gracilis* SCHWAEGR.

4: The distinction among the epidermal, cortical layer and central strand is clear and the central strand is composed of less than fifteen cells (c group), *Gr. laevigata* (BRID.) BRID.

These facts have to be taken into consideration in order to establish the representative structure of the stem. All the observations were made by 600 magnifications, but Plate XXIV-LXIV are of 400 magnifications. By way of comparison the inner structures of the stem are divided into the following four types (Fig 6 and Table 62).

Type a : Distinctions between the epidermal and cortical layer, and between the cortical layer and central strand are quite obscure. The cross section of stem is composed of uniform cells (Fig 6 No. 1)

Type b : The distinction between the epidermal layer and cortical layer is clear but the distinction between the cortical layer and central strand is not (Fig 6 No. 3).

Type c : The distinctions between the epidermal layer and cortical layer, and between the cortical layer and central strand are clear. The central strand is composed of less than fifteen cells (Fig 6 No. 4).

Type d : The distinctions between the epidermal and cortical layer, and between the cortical layer and central strand are clear. The central strand is composed of more than fifteen cells (Fig 6 No. 2).

3. The Relationship between the Structure of the Midrib and that of the Stem

Based on the characteristics of the stem, the species are divided into four types. Table 63 shows the relationship of those types of stem structure with the cell number

Table 63. Relationship between the structure of the stem and numerical characteristics of the midrib.

Numerical characteristics of the midrib	Types of the structure of the stem			
	a group	**b group**	**c group**	**d group**
a Cell number of a-part	Mean value 2.0	Mean value 4.0	Mean value 5.5	Mean value 7.4
	2a	2a, 3a, 4a, 5a, 6a	2a, 4a, 5a, 6a, 7a, 9a	4a, 6a, 7a, 9a, 11a
T The total number of the cells	Mean value 15	Mean value 25	Mean value 30	Mean value 70
	14, 17	18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 34, 35	13, 14, 16, 18, 21, 23, 27, 28, 35, 39, 40, 48, 59	36, 48, 51, 59, 82, 84, 96, 103
I Importance index	Mean value 10	Mean value 18	Mean value 18	Mean value 45
	9, 12	12, 13, 14, 15, 16, 18, 19, 20, 23, 24	8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 25, 26, 29, 30, 35	23, 33, 34, 38, 49, 54, 62, 64

of the **a-part**, the total cell number of the midrib and the importance index. In the table I notice the following tendencies: (1) Those which show slightly differentiated inner structures of the stem (like **Group a** in the table) have fewer cells at the **a-part** of the midrib; those apparently with highly differentiated structures (like **Group d**) have a greater number of cells in the **a-part**. (2) Little differentiated inner structures coincide with a smaller total number of cells of the midrib; but highly differentiated stem structures have larger values of the total cell number. (3) As for the importance index, nearly the same tendency is noticed as in the case of the total cell number.

Thus a certain correlation exists between the differentiation of the inner structure of the stem and the number of the cells in the cross section of the midrib. That is to say, the more advanced the differentiation of the inner structure of the stem is, the greater increase the number of the cells of the **a-part**, the total number of the cell of the midrib and the importance index, are likely to attain.

Table 64. Relationship between the structure of the stem and morphological characteristics of the midrib.

Types of the structure of the stem	Types of morphological characteristics of midrib			
	A group	**B group**	**C group**	**D group**
a group	I *alpicola* *conferta*	II *donniana* *mollis*		
b group	II *agassizii* *gracilis* *humilior* *incurva* *pilifera* *subepilosa* *torquata*	III *acutifolia* *apocarpa* *decalvata* *elatior* *epilosa* *microtheca* *rivularis* *tenerrima*		
c group	III *atrofusca* *calvescens* *longipila* *tenuis*	IV *africana* *anodon* *anomala* *funalis* *hartmanii* *lisae* *persica* *pulvinata* *teretinervis*	V *laevigata* *plagiopodia*	VI *maritima*
d group	IV *cratericola*		VI *arizonae* *decipiens* *ovalis* *patens* *robusta*	VII

It has already been mentioned that there is a certain parallelism between the morphological characteristics of the midrib structure and its numerical characteristics.

Table 64 summarizes the relations between the structure of the stem and the morphological characteristics of the midrib. The following results are clear from the table. (1) Those with a greater inner differentiation in the stem structure generally show a more advanced inner differentiation in the midrib. For example, if the midrib is in **A group**, the stem is mostly in **a**, **b**, or **c**; if the midrib is in **D group**, the stem has a characteristic which comes under **c**. This indicates a general parallelism between the two structures. (2) Since there exists a certain parallelism between the inner structural differentiation of the stem and that of the midrib, in Table 64, groups are arranged in the order of the degree of differentiation: from **A-a type** (**Group I**) least differentiated both in the stem and in the midrib to **D-d type** (**Group VII**) most differentiated in both and between them there are **A-b** and **B-a types** (**Group II**), **A-c** and **B-b types** (**Group III**), **B-c** and **A-d types** (**Group IV**), **C-c type** (**Group V**), **C-d** and **D-c types** (**Group VI**). If this order is followed, the number of the cells of the **a-part** shows a parallel increase. The total cell number of the midrib and the importance index generally tend to increase but do not always increase proportionately. These facts indicate a parallelism either strict or loose between the structural characteristics of the stem and those of the midrib.

4. External Morphology of the Gametophyte

In the external morphology of the gametophyte, the shape of both leaves and leaf cells is most important taxonomically. The shape of leaves has characteristics of whether the leaf is of sharp- or dull-apex, whether the hyaline point is present or not, whether the point is indented or not, whether the leaf margin is one cell thick, whether the upper half of the leaf margin is two cells thick, or the entire leaf margin is two cells thick, and whether the lamina is one or two cells thick. Leaf cells have different characteristics depending on whether they are from the apex, the middle or the base. The cell shape is quite irregular and complicated and is hard to describe, but seems to have distinct characteristics which are peculiar to the species.

(1) The Shape of the Leaf Cell

Leaf cells have various, irregular shapes and it is difficult to give a unified description. However, at least the three parts of lamina, namely, the apex, middle and the base have their own respective structures within a limited variation and this structure seems to have characteristics which are quite peculiar to the species. I employed the conditions of the cell wall as a means to describe this structure. That is to express the characteristics of cells by a combined description of the "**cross**" cell wall, which runs at right angles with the midrib and the "**longitudinal**" cell wall, which runs parallel to the midrib. As the conditions of the cell wall I chose the following items:

1. Condition of the axis of cell wall.

2. Thickness of the cell wall.
3. Angle of meeting of "cross" and "longitudinal" wall.
4. Ratio of length of "cross" and "longitudinal" wall.

Of the possible combinations of these characteristics, only the following fifteen types were actually observed (Table 65, Plate XXII). In observing the shape of the cell, the condition of the longitudinal cell wall is very distinctly seen. The condition of the longitudinal cell wall is what has generally been emphasized taxonomically. On the basis of the condition of this longitudinal wall, I can regroup the fifteen types into the following three Groups:

Group A. The axis of the wall straight or waved and the wall of uniform thickness.

Group B. Rippled and uniform in thickness.

Group C. Straight or rippled and irregular in thickness.

Table 65. Fifteen types in possible combinations of characteristics of leaf cell wall.

Longitudinal wall		Cross wall	Longitudinal and cross wall		Types
Cell wall uniform in thickness	A Axis of wall straight or waved	Axis of wall straight	1 same in thickness	a Length of cross $<$ long.	A1a
				b Length of cross $=$ long.	A1b
			2 Not same in thickness		A2
		3 Waved	Length of cross c. w. $<$ length of long. c. w.		A3
	B Rippled	Uniform in thickness	1 Length of cross $<$ long.	a Right angle	B1a
				b Oblique angle	B1b
			2 Length of cross $>$ long.	a Right angle	B2a
				b Oblique angle	B2b
			3 Length of cross $=$ long.	a Right angle	B3a
				b Oblique angle	B3b
		4 Not uniform in thickness			B4
C Cell wall not uniform in thickness	Rippled	1 Rippled	a Length of cross $>$ longitudinal		C1a
			b Length of cross $=$ longitudinal		C1b
		2 Straight	Length of cross $<$ longitudinal		C2
	3 Straight		Right angle		C3

Table 66. Types of the structures of the leaf cells.

Groups of the types	Type of the structures of base, middle, apex	Species
A–A–A	A1a–A1b–A1b	*mollis*
A–B–B	A1a–B1a–B3a	*acutifolia, decalvata*
	A1a–B1b–B3a	*hartmanii, maritima*
	A1a–B2a–B3a	*anomala*
	A1a–B2a–B2a	*tenerrima*
	A1a–B2b–B2a	*donniana*
	A1a–B2b–B3a	*incurva*
	A1a–B3a–B3a	*humilior, teretinervis, plagiopodia, ovalis, funalis*
	A2–B3a–B3a	*pulvinata*
	A3–B3a–B3a	*rivularis, microtheca*
	A3–B3b–B3a	*agassizii*
A–C–B	A1a–C2–B3a	*calvescens*
A–C–C	A3–C1b–C1a	*alpicola*
B–B–B	B1a–B1a–B3a	*cratericola, africana*
	B1a–B2b–B3a	*subepilosa*
	B1a–B3a–B3a	*tenuis, anodon, atrofusca, epilosa*
	B1a–B3a–B3b	*conferta*
	B1a–B3b–B3a	*elatior, torquata*
	B4–B3a–B3a	*persica, gracilis*
C–B–B	C2–B1a–B2a	*lisae*
C–C–C	C1a–C1a–C1a	*laevigata*
	C2–C2–C1a	*apocarpa*
	C3–C2–C2	*decipiens*
	C3–C3–C3	*arizonae, robusta, pilifera*

I get Table 66 as a result of this grouping. Leaf cells taken from the three parts, the apex, the middle and the base have been separately observed. Since those from the base are most characteristic, I mark down the characteristics in order from the base through the middle to the apex. In *Gr. decalvata*, for instance, they are **Ala-Bla-B3a.** In this way the shapes of the cell in a particular part of a particular species always has the same notation. For the sake of confirmation, as many observations as possible have been made. If the specimens studied are abundant, the confirmation is fully made but not so in the case of scant specimens. Generally speaking, I find by this method that the shape and the size of the leaf cells are peculiar to the species. Irrespective of the method I use, it seems that the conditions of the leaf cell play a taxonomically important role.

Of the morphological characteristics of the cell, I select the conditions of the longitudinal cell wall which have been believed to be taxonomically important and group them into the afore-mentioned three groups : **A (Ala, Alb, A2, A3), B**

(**B1a**, **B1b**, **B2a**, **B2b**, **B3a**, **B3b**, **B4**) and **C** (**C1a**, **C1b**, **C2**, **C3**). Thus I get Table 66, in the extreme left column of which are arranged the conditions of the vertical cell wall with special emphasis on whether the cell wall I notice from the table: (1) Consistent from the base to the apex of the leaf, like **A-A-A**, **B-B-B**, or **C-C-C**. (2) Each part different, like **A-C-B**; (3) Two parts the same: **A-B-B**, **A-C-C**, **C-B-B**. (4) If the base is **A** or **C**, the middle and the apex are all different except in *Gr. mollis* ; whereas if the base is **B**, the other parts are all **B**.

Among the characteristics of **A**, **B** and **C**, there exists the relation, **A**→**B**→**C**. That is, many have **A** and **B** but few have **A** and **C**. As for **C**, many have **C** and **B** but if the base is **C**, none of the other part is known to be **A**. This relation suggests that these characteristics are likewise formed in order from straight through waved to verruculose.

(2) Morphology of the Leaf

The shape of the leaf is considered to be very important in taxonomy, but, since it is subject to individual variation, it is necessary to observe a great number of specimens collected from different localities. Here I observe the whole shape, margin and apex of the leaf. The whole shape of the leaf is various depending on the part of the stem it attachs to. Leaves from the bottom of the plant called "folia caulina inferiora" are frequently modified and small in size. Leaves from the top of the plant called "folia caulina superiora" are often young and incomplete or sometimes happen to

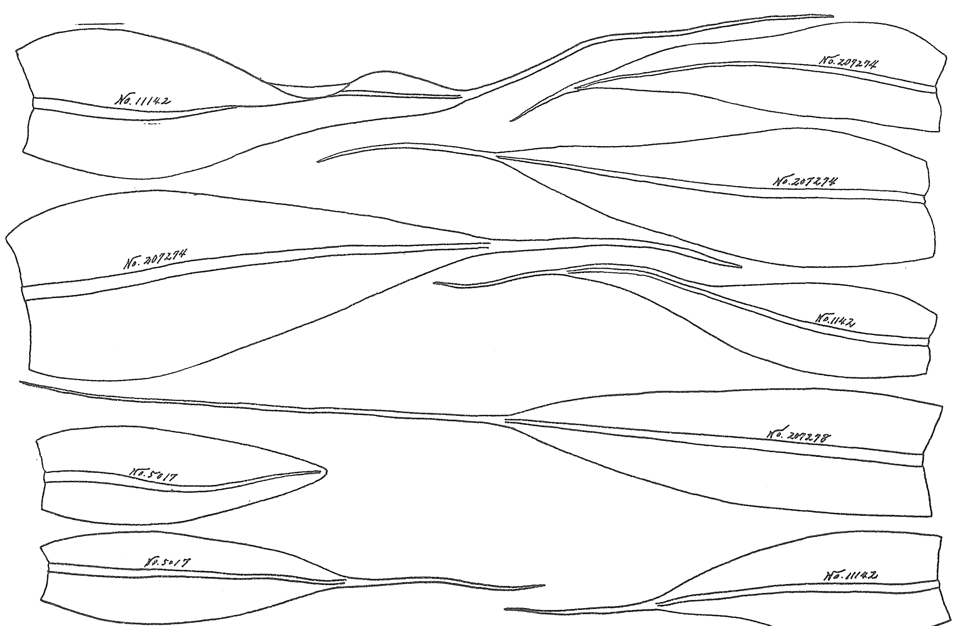


Fig 7. A variation of the leaf-shape in *Gr. pulvinata* (HEDW.) SM.

be perichaetium, which are very different in shape from folia caulina. It is necessary, therefore, to observe the leaves from the parts other than the top and the bottom of the plant.

Fig. 7 shows a variation of the leaf-shape in *Gr. pulvinata.* In some species the leaf is almost unvaried in size and shape but in some other species the leaf is subject to a considerable degree of variation as to the size and the shape. It is necessary to give both the typical shape and the extent of variation in order to taxonomically establish a leaf-characteristic, but, since a sufficient number of specimens are not obtained from many enough localities, only the variation observed has here been diagramed. From among the characteristics of the margin, apex, and lamina of the leaf, I select the following items (Table 67, Fig 8):

Table 67. Items of the characteristics of leaf margin, leaf apex and lamina.

Leaf margin	M
One cell in thickness	o
Two or three cells in thickness at the upper half	h
Two or three cells in thickness from apex to base	t
Leaf margin not toothed	n
Leaf margin toothed	p
Leaf apex	E
Dull-ended apex	d
Sharp-ended apex	s
Leaf apex with a hyaline point*	l
Leaf apex without a hyaline point	c
Hyaline point toothed	a
Hyaline point not toothed	b
Lamina	F
One cell in thickness	y
Two cells in thickness**	w

* In *Gr. anodon*, folia caulina inferiora have no hyaline point but folia caulina superiora are with a hyaline point. Folia caulina superiora of *Gr. funalis* have not always a hyaline point which is, however, found in folia caulina inferiora. In these cases, I treted both the species as having a leaf apex with a hyline point.

** In *Gr. anodon*, lamina is mostly found to be two cells in thickness but partly one cell. I considered, therefore, that lamina of *Gr. anodon* is generally built two cells in thickness. In contrast to this, lamina of *Gr. alpicola* is generally composed of one cell in thickness but rarely two cells. It is generally thought that, in *Gr. alpicola*, lamina is built by one cell in thickness.

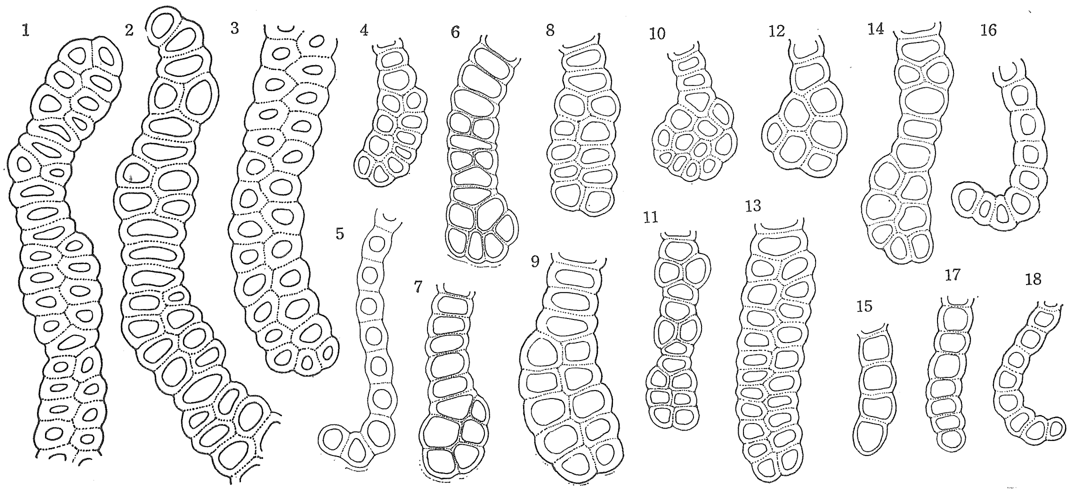


Fig 8. Characteristics of leaf margin and lamina.
1–3: Lamina with two cells in thickness, 5: Lamina with one cell in thickness, 4, 6–14: Leaf margin with two or three cells in thickness, 15–18: Leaf margin with one cell in thickness. 1: *Gr. maritima* Turn. 2: *Gr. anodon* B.S.G. 3: *Gr. elatior* Bruch 4: *Gr. pilifera* P. Beauv. 5: *Gr. hartmanii* Schimp. 6: *Gr. pulvinata* (Hedw.) Sm. 7: *Gr. pulvinata* (Hedw.) Sm. 8: *Gr. decalvata* Card. 9: *Gr. donniana* Sm. 10: *Gr. pilifera* P. Beauv. 11: *Gr. donniana* Sm. 12: *Gr. apocarpa* var. *rivularis* (Brid.) Nees et Hornsch. 13: *Gr. ovalis* (Hedw.) Lindb. 14: *Gr. decalvata* Card. 15: *Gr. apocarpa* var. *rivularis* (Brid.) Nees et Hornsch. 16: *Gr. hartmanii* Schimp. 17: *Gr. alpicola* Hedw. 18: *Gr. apocarpa* var. *rivularis* (Brid.) Nees et Hornsch.

Table 68. Seventy-two combinations of the characteristics of the leaf margin, leaf apex and lamina.

E	F	M					
		po	ph	pt	no	nh	nt
dc	y	MpoEdcFy	**MphEdcFy**	MptEdcFy	MnoEdcFy	MnhEdcFy	MntEdcFy
	w	MpoEdcFw	MphEdcFw	MptEdcFw	MnoEdcFw	MnhEdcFw	MntEdcFw
sc	y	MpoEscFy	**MphEscFy**	**MptEscFy**	**MnoEscFy**	**MnhEscFy**	**MntFscFy**
	w	MpoEscFw	**MphEscFw**	**MptEscFw**	MnoEscFw	**MnhEscFw**	**MntEscFw**
dla	y	MpoEdlaFy	MphEdlaFy	MptEdlaFy	MnoEdlaFy	MnhEdlaFy	MntEdlaFy
	w	MpoEdlaFw	MphEdlaFw	MptEdlaFw	MnoEdlaFw	MnhEdlaFw	MntEdlaFw
sla	y	MpoEslaFy	MphEslaFy	MptEslaFy	**MnoEslaFy**	**MnhEslaFy**	MntEslaFy
	w	MpoEslaFw	MphEslaFw	MptEslaFw	**MnoEslaFw**	**MnhEslaFw**	MntEslaFw
dlb	y	MpoEdlbFy	MphEdlbFy	MptEdlbFy	MnoEdlbFy	MnhEdlbFy	MntEdlbFy
	w	MpoEdlbFw	MphEdlbFw	MptEdlbFw	MnoEdlbFw	MnhEdlbFw	MntEdlbFw
slb	y	MpoEslbFy	MphEslbFy	MptEslbFy	MnoEslbFy	**MnhEslbFy**	MntEslbFy
	w	MpoEslbFw	MphEslbFw	MptEslbFw	MnoEslbFw	MnhEslbFw	MntEslbFw

Table 69. Groupings of fourty-one spceies of *Grimmia* based on morphological characteristics of the leaf margin, leaf apex and lamina.

E	F	M: ph	M: pt	M: no	M: nh	M: nt
dc	y	MphEdcFy				
		plagiopodia *mollis*				
sc	y	MphEscFy	MptEscFy	MnoEscFy	MnhEscFy	MntEscFy
		alpicola *rivularis*	*subepilosa*	*anomala* *cratericola* *torquata*	*acutifolia* *agassizii* *atrofusca* *calvescens* *decalvata* *donniana* *epilosa* *humilior* *incurva* *patens* *robusta*	*apocarpa* *gracilis* *hartmanii*
	w	MphEscFw	MptEscFw		MnhEscFw	MntEscFw
		teretinervis	*tenuis*		*elatior* *tenerrima*	*maritima*
sla	y			MnoElaFy	MnhFslaFy	
				persica	*conferta* *microtheca* *ovalis* *pilifera* *pulvinata*	
	w			MnoEslaFw	MnhEslaFw	
				laevigata	*anodon* *arizonae* *decipiens* *funalis* *longipila*	
slb	y				MnhEslbFy	
					africana *lisae*	

As is shown in Table 68, seventy-two combinations of these characteristics are possible, but only fifteen shown in gothic type in the table were actually observed in the species treated. Table 69 shows the result of classification of these types. Considerations have to be made concerning the variation of the shape of the margin and the apex of the leaf. The variation is fairly great in certain species and my ecological study of those species revealed that structural differences are seen between

hygrophytes and **xerophytes**. In this experiment, I collected plants of *Gr. apocarpa* from six dry places and four moist places and observed the apex of thirty specimens of the respective places. Some types are found in both the wet and dry habitats (Plate XXIII), but in dry places cells are greatly lengthened, the apex has a long hyaline point, and the indentions are distinct (No.1 of Plate XXIII). On the other hand, in wet places, cells are more or less round, the hyaline point is usually not found, and indentious are obscure or sometimes even absent (No. 5 of Plate XXIII). Thus in wet places, cells of the leaf especially at the apex are short, but in dry places, they tend to be long and, as its probable result, the hyaline point and indentions become conspicuous.

The **hydrophytes** and **hygrophytes** of mosses have leaves which are in most cases wide, egg-shaped or oval; whereas the **xerophytes** have narrow, sharp-ended leaves (for instance, spear-head-shaped). This leads us to suppose that leaf cells of the **xerophytes** tend to be elongated and that leaf cells of the **hydrophytes** and **hygrophytes** tend to be shortened-round or square. Such a conclusion cannot be reached unless all the Musci have been studied, but the result of the observation of *Grimmia* alone gives me the above suggestion.

IV. Discussion

Using fourty-one species of *Grimmia*, I studied the affinity among morphological characteristics mainly of the gametophyte with primary emphasis on its inner structure. In order to see the taxonomical significance of the divisions of these characteristics, I prepare Table 70, which shows the correspondence of the species arranged in LOESKE's system of classification to the following ten divisions of the characteristics observed.

(1) Constitutional formulae of the midrib.
(2) Morphological differentiation of the midrib.
(3) Number of the cells in the **a-part**.
(4) Ontogeny of the midrib (the **a-part** as criterion).
(5) Ontogeny of the midrib (each of the **a-**, **b-**, and **c-parts** as criteria).
(6) Structure of the stem.
(7) Combined structure of the stem and the midrib.
(8) Structure of leaf cells.
(9) Structure of the leaf apex.
(10) Structure of the leaf margin.

As is shown in Table 70 No.2, the species are divided into four categories depending on the degree of differentiation in the midrib. Those with a smaller degree of tissue differentiation are more common in an older branch of the genealgical tree such as *Schistidium* and *Gastrogrimmia*. More differentiated species are those constituting a younger branch of the tree such as *Rhabdogrimmia*, *Alpinae*, and *Litoneurum*. Thus the

Table 70. The correspondence of the species studied arranged in LOESKE's system of classification to the ten divisions of the characteristics observed.

Species	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Schistidium										
alpicola	2a+6b+9c=17	B	2a	2a−2a−2a−2a	IA	a	II	A	Esc	Mph
agassizii	2a+14b+8c=24	B	2a	2a−2a−2a−2a	IB	b	III	A	Esc	Mnh
subepilosa	2a+7b+9c=18	A	2a	2a−2a−2a−2a	IA	b	II	B	Esc	Mpt
gracilis	2a+8b+9c=19	A	2a	2a−2a−2a−2a	IA	b	II	B	Esc	Mnt
tenuis	2a+13b+12c=27	A	2a	2a−2a−2a−2a	IA	c	III	B	Esc	Mpt
humilior	3a+10b+10c=23	A	3a	2a−2a−2a−2a	IA	b	II	A	Esc	Mnh
epilosa	3a+13b+13c=29	A	3a	2a−2a−2a−2a	IA	b	II	B	Esc	Mnh
rivularis	2a+10b+9c=21	A	2a	2a−2a−2a−2a	IA	b	II	A	Esc	Mph
atrofusca	2a+10b+10c=22	A	2a	2a−2a−2a−2a	IA	c	III	B	Esc	Mnh
conferta	2a+10b+12c=24	A	2a	2a−2a−2a−2a	IA	a	I	B	Esla	Mnh
microtheca	2a+12b+11c=25	B	2a	2a−2a−2a−2a	IA	b	III	A	Esla	Mnh
apocarpa	2a+13b+12c=27	B	2a	2a−2a−2a−2a	IA	b	III	C	Esc	Mnt
acutifolia	5a+18b+12c=35	B	5a	2.3a−3.4.5a	IIB	b	III	A	Esc	Mnh
tenerrima	6a+13b+15c=34	B	6a	2a−2.3a	IIA	b	III	A	Esc	Mnh
teretinervis	4a+11b+8c=23	B	4a	2a−2.3a	IIA	c	IV	A	Esc	Mph
maritima	11a+54b+18c=82	D	11a	3a−4.5.6a	IIB	c	VI	A	Esc	Mnt
Hydrogrimmia										
mollis	4a+12b+8c=24	B	4a	2.3a−3.4.5a	III	a	II	A	Edc	Mph
Litoneurum										
pilifera	2a+6b+12c=20	A	2a	2a−2a−2a−2a	IA	b	II	C	Esla	Mnh
laevigata	9a+13b+18c=40	C	9a	2.3a−3.4.5a	IIB	c	V	C	Esla	Mno
Gastrogrimmia										
plagiopodia	2a+8b+6c=16	B	2a	2a−2a−2a−2a	IA	c	IV	C	Edc	Mph
cratericola	6a+7b+14c=27	A	6a	3a−4.5.6a	IIB	d	IV	B	Esc	Mno
anodon	11a+5b+9c=21	B	11a	2.3a−3.4.5a	IIB	c	IV	B	Esla	Mnh
Alpestres										
donniana	2a+11b+11c=24	B	2a	2a−2a−2a−2a	IA	a	II	A	Esc	Mnh
decalvata	2a+13b+15c=30	A	2a	2a−2a−2a−2a	IA	b	II	A	Esc	Mnh
Pulvinatae										
persica	2a+5b+6c=13	B	2a	2a−2a−2a−2a	IA	c	IV	B	Esla	Mno
pulvinata	2a+8b+6c=16	B	2a	2a−2a−2a−2a	IA	c	IV	A	Esla	Mnh
africana	2a+10b+11c=23	B	2a	2a−2a−2a−2a	IA	c	IV	B	Eslb	Mnh
Alpinae										
incurva	2a+11b+15c=28	A	2a	2a−2a−2a−2a	IA	b	II	A	Esc	Mnh
ovalis	7a+26b+18c=51	C	7a	3a−4.5.6a	IIB	d	VI	A	Esla	Mnh
arizonae	11a+49b+36c=96	C	11a	2a−2a−2.3a	IIA	d	VI	B	Esla	Mnh
Torquatae										
calvescens	2a+4b+7c=13	A	2a	2a−2a−2a−2a	IA	c	III	A	Esc	Mnh
torquata	2a+5b+7c=14	A	2a	2a−2a−2a−2a	IA	b	II	B	Esc	Mno
longipila	2a+6b+8c=16	A	2a	2a−2a−2a−2a	IA	c	III	C	Esla	Mnh
funalis	2a+9b+10c=21	B	2a	2a−2a−2a−2a	IA	c	IV	A	Esla	Mnh
Rhabdogrimmia										
lisae	2a+11b+8c=21	B	2a	2a−2a−2a−2a	IA	c	IV	C	Eslb	Mnh
elatior	2a+14b+12c=28	B	2a	2a−2a−2a−2a	IA	b	III	B	Esc	Mnh
anomala	2a+28b+18c=48	A	2a	2a−2a−2a−2a	IA	c	III	A	Esc	Mno
hartmanii	4a+18b+16c=38	B	4a	2a−2a−2.3a	IIA	c	IV	A	Esc	Mnt
robusta	6a+33b+20c=59	C	6a	3a−4.5.6a	IIB	d	VI	C	Esc	Mnh
decipiens	7a+20b+21c=48	C	7a	3a−4.5.6a	IIB	d	VI	C	Esla	Mnh
patens	7a+71b+25c=103	C	7a	3a−4.5.6a	IIB	d	VI	C	Esc	Mnh

structural characteristics of the midrib correspond in many ways with the system of classification now being considered.

No.3 shows divisions by the lineal counting of cells in the *a-part*. The group with the fewest number of cells, that is two or three cells, are frequent in *Schistidium*, *Pulvinatae* and *Torquatae*. Those with the larger number of cells, that is eleven, nine or seven cells, are concentrated in *Alpinae*, *Rhabdogrimmia*, *Litoneurum*, etc. On the whole, however, no definite correlation exists as it did in No.2.

No.4 is the processes of the ontogeny of the midrib with the use of the number of cells in the **a-part** as criterion. The type in which the **a-part** is of two to three cells at earlier stages of ontogeny is characteristic to *Schistidium*, *Torquatae*, etc. Another type which has a larger number of cells already at the earlier stage belong to *Rhabdogrimmia*, *Gastrogrimmia* or *Litoneurum*.

No.5 is a classification by ontogeny of the midrib in each of the **a-**, **b-**, and **c-part**. All or most of *Schistidium* and *Torquatae*, etc. come under **I-A**. *Rhabdogrimmia* is characterized by **II-B**.

No.6 divides the species into four types from the least differentiated to the most differentiated stem-structure. The least differentiated are more common in *Schistidium*. On the other hand, the most differentiated are seen in *Rhabdogrimmia* and *Alpinae*.

No. 7 presents types of combined structure of the stem and midrib. Here the characteristics of the stem and those of the midrib are at once considered. Those least advanced in differetiation of the midrib and the stem as well mostly belong to *Schistidium*, *Torquatae*, etc. The most differentiated species in both mostly belong to *Rhabdogrimmia*, *Alpinae*, etc.

From the tables (Table 63, 64, 70) I see that the species which belong to a certain subgenus come under one and the same group or sometimes divide themselves into a few groups but do not scatter widely. Occasionally, however, species which belong to one subgenus are widely distributed. This needs to be carefully examined, but I may generally say as follows. The inner structures, especially morphological characteristics of the stem and the midrib correspond to a good extent with LOESKE's system of classification.

No.8 is groups classified by the morphological characteristics of the cell wall. The relations among these groups are not clear but the general tendency $\mathbf{A} \rightarrow \mathbf{B} \rightarrow \mathbf{C}$ or $\mathbf{C} \rightarrow \mathbf{B} \rightarrow \mathbf{A}$ is recognizable. Species with **A** or **B** mainly belong to *Schistidium*, *Torquatae*, etc. Those with **C** are more frequent in *Rhabdogrimmia*. On the whole, however, no distinct tendency is observed.

No.9 shows combinations of characteristics of the leaf apex. If the advancement is from the dull-ended through the sharp-ended to the hyaline-pointed and deeply indented, the direction is **Edc**→**Esc**→**Eslb**→**Esla**. This tendency is highly correlated with the ecology of the species, namely, whether they are hydrophytic, hygrophytic, or xerophytic. *Hydrogrimmia* is the extreme of hydrophyte and shows **Edc**, whereas *Litoneurum* is the extreme of xerophyte and shows **Esla**.

No.10 is combinations of the structural characteristics of the leaf margin. No relationship between these characteristics and the classification system is traceable.

Now I can see that the characteristics of the structure of the gametophyte—especially the inner structure—have to be considered as being taxonomically important since they may not perfectly fall in with the traditional classification-system but certainly there is a degree of parallelism between them and the traditional classification-system.

A certain amount of correlation is known to exist between the inner structure of the midrib and those of the stem, and so I propose the system of classification shown in Fig.9. Fig.9 divides the species into three large divisions, which are further divided into subdivisions. The classification is primarily based on the number of the cells in the **a-part**, but ontogeny of the midrib, the structure of the midrib, the structure of the stem, etc. are also taken into consideration.

Thus similar species are put together side by side and the following groups are delineated: groups based on the structure of the midrib, the number of cells at the **a-part**, the ontogeny of the midrib (the number of the **a-part** as criterion), the ontogeny of the midrib (the number of the **a-**, **b-** and **c-part** as criteria), the structure of the stem, the structures of both the stem and the midrib, the shape of the areolation, the structure of the leaf apex, the structure of the leaf margin. These groups are divided into three divisions where demarcation lines are thickest. These three divisions are in turn divided into subgroups delineated with dotted lines. As shown in Fig 9, **Group A**, **Group B** and **Group C** resulted from this classification.

The classification thus obtained is by no means complete, but it is based on the affinity determined through the consideration of all the structural characteristics of the gametophyte. I believe that it reveals much of the true taxonomy of *Grimmia*.

V. Summary

I observed mainly the gametophyte of fourty-one species of *Grimmia*, a genus which belong to Grimmiaceae. The characteristics of the gametophyte are divided into the internal and the external.

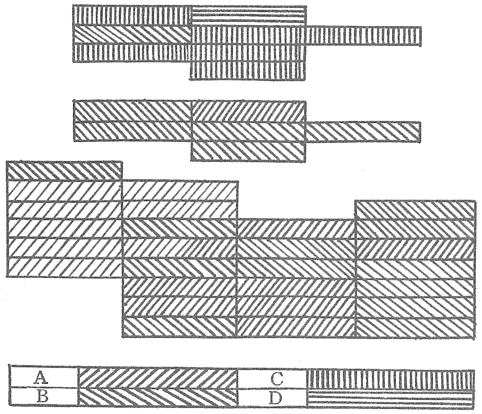
As internal characteristics, those of the stem and the midrib were observed. Internal characteristics are divided into four groups depending on whether the cross section of the stem reveals distinct differentiation in the epidermal layer, cortical layer and central strand. The structures of the midrib are divided into four groups depending on whether the internal and external differentiations are clear or not. The tissue of the midrib is then genetically divided into three parts : **a-part** which is adaxial, **c-part** which is abaxial and **b-part** which is enclosed by **a-** and **c-part**. In each of these parts, the number of cells which constitute the part was counted and compared. It is noted that the number of cell at the **a-part** is especially peculiar to the species. By

way of comparison the number of cells at the **a**-, **b**- and **c-part** and their sum **T** were put together in **a+b+c=T** so as to represent the complete midrib structure. The processes in the ontogeny of the midrib structure were likewise tracked down and thus similarities in the ontogeny of the midrib were examined. I note that there exists a certain amount of parallelism between classification by the degree of differentiation and by that the number of cells in the **a-part**, and the other parts. That is to say the species which show little differentiation in the internal structures of the midrib have fewer cells in the **a-part** and also in the total number of the midrib and the species more differentiated have a greater number of cells in them. Another parallelism is noted that species more differentiated in the midrib are likewise differentiated in the stem. Generally speaking, therefore, classifications by internal structures have mutual correlations.

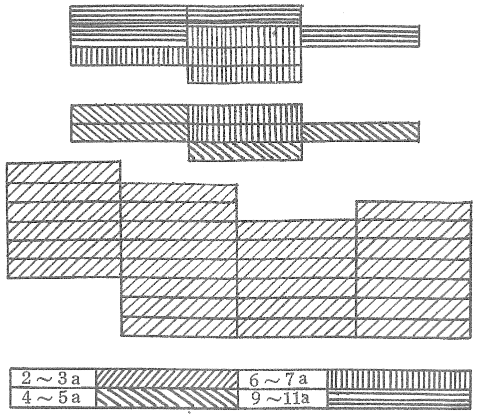
As external characteristics, first of all, cells were taken from the three parts of the apex, the middle and the base of the leaf and their shapes are examined and compared. In order to simplify this comparison, the cell wall which runs parallel to the midrib is named longitudinal cell wall and the cell wall which crosses the midrib is named cross cell wall, and then the cell shape is defined by the description of these two cell walls. The characteristics observed are as to whether the cell walls are straight, waved or rippled; uniform in thickness or lacking uniformity; whether the two walls meet at right angles or cross obliquely; whether the longitudinal cell wall is longer or thicker than the cross wall, etc. Of all the combinations of these characteristics, only fifteen types of combinations were actually observed. These characteristics were observed at the leaf apex, middle and the base of the leaf and then compared. They are finally divided into seven groups (Table 66).

External characteristics of the leaf were examined as to the apex, leaf margin and lamina. The apex was observed as to whether it is sharp-ended or dull-ended, whether the hyaline point is present or not, whether the hyaline point is indented or not, etc. The leaf margin was checked as to whether it is one-cell thick, whether the upper half or the whole length is two-cells thick and whether the leaf margin is indented. The lamina as whole was observed as to whether it is one-cell or two-cells thick. Of 72 possible combinations, only 15 types were actually observed (Table 69).

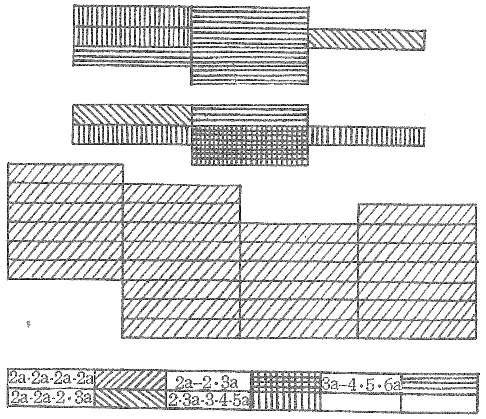
Some of the characteristics observed in the gametophyte are considered to be peculiar to the species (although a certain variation is to be allowed for) and hence taxonomically significant. I therefore, tryed to establish a classification of fourty-one species of *Grimmia* here treated. As shown in Fig 9, they are divided into three groups: A, B and C, each of which is in turn divided into several subgroups. The tendency is A→B→C. In this classification, divisions are made where demarcation lines are thickest between groups by all the characteristics observed of the gametophyte. It is by no means perfect since not the characteristics of the sporophyte but the characteristics of the gametophyte alone are here treated, but the system seems to



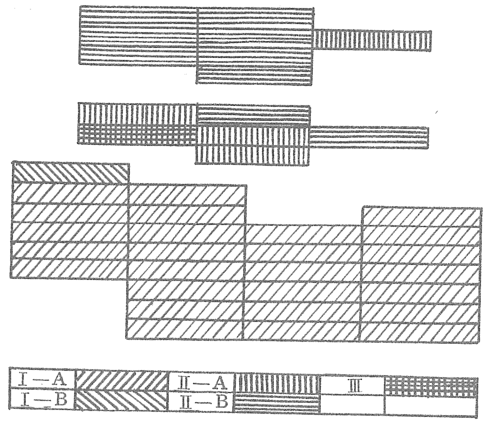
1) Morphological differentiation of the midrib.



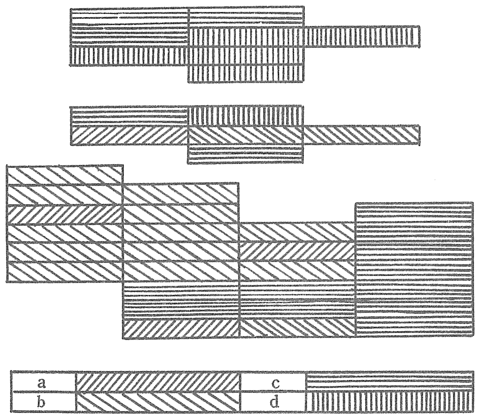
2) Cell number of the a-part of the midrib.



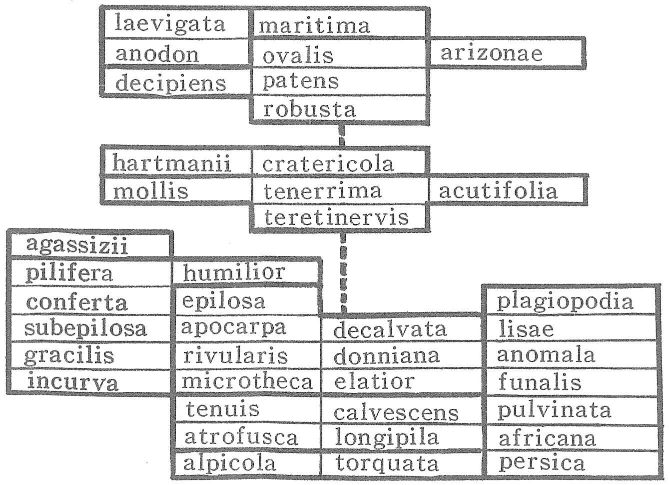
3) Ontogeny of the midrib (the a-part as criterion).



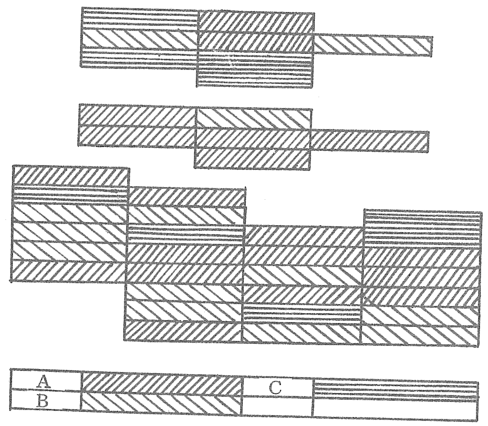
4) Ontogeny of the midrib (each of the a-, b-, and c-part as criteria).



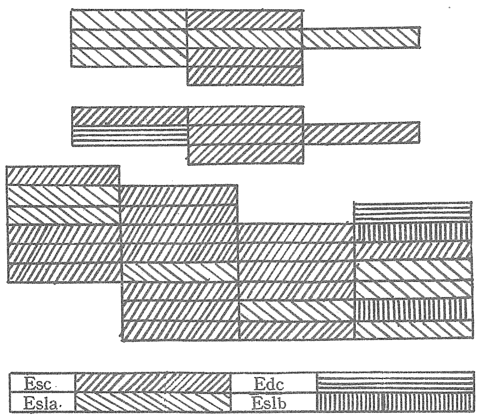
5) Structure of the stem.



9) The system of classification divided into some subgroups based on the characteristics of the gametophyte.

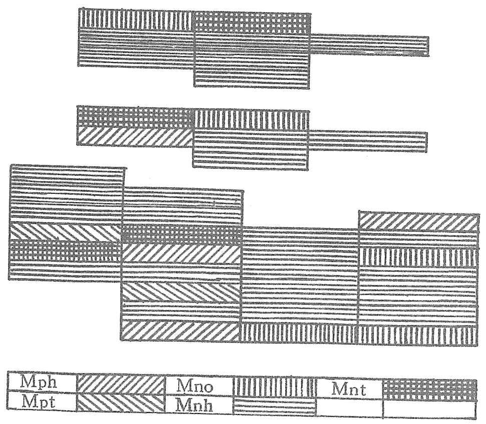


6) Structure of the leaf cells.



7) Structure of the leaf apex.

Fig 9 . The classification based on the affinity determined through the consideration of all the structural characteristics of the gametophyte.



8) Structure of the leaf margin.

reveal something of the true classification.

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Explanation of Plates

Plate I-XXI : Observation of stages in the ontogeny of their midribs in the fourty-one species of *Grimmia*.

Plate XXII : Fifteen types in possible combinations of characteristics of leaf cell wall.

Plate XXIII : Some types of the leaf apex are found in both dry and wet habitats (*Gr. apocarpa*).

Plate XXIV-LXIV : Observation of external morphology and inner structures in the fourty-one species of *Grimmia*.

Plate I

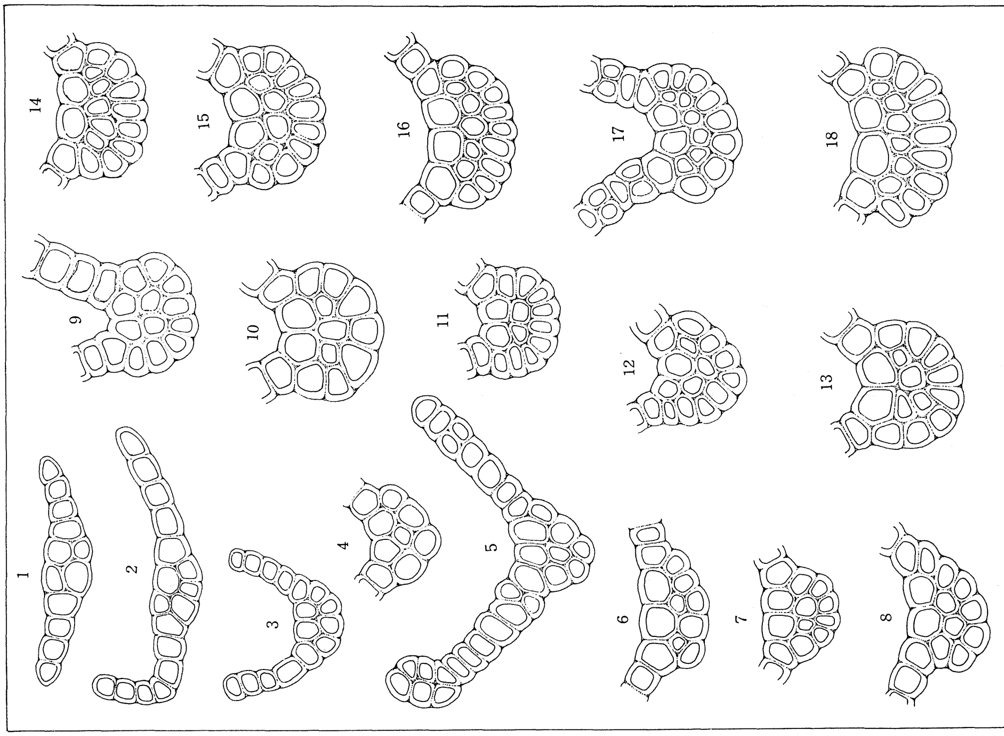
No. 1. *Gr. agassizii* (SULL. et LESQ.) JAEG.

1. 2a+0b+3c=5
2. 2a+1b+3c=6
3. 2a+3b+4c=9
4. 2a+3b+3c=8
5. 2a+5b+4c=11
6. 2a+4b+4c=10
7. 2a+5b+5c=12
8. 2a+4b+5c=11
9. 2a+6b+4c=12
10. 2a+6b+5c=13
11. 2a+7b+4c=13
12. 2a+5b+6c=13
13. 2a+6b+6c=14
14. 2a+8b+4c=14
15. 2a+7b+5c=14
16. 2a+7b+6c=15
17. 2a+8b+5c=15
18. 2a+6b+7c=15
19. 2a+8b+6c=16
20. 2a+8b+7c=17
21. 2a+7b+7c=16
22. 2a+7b+8c=17
23. 2a+10b+6c=18
24. 2a+10b+5c=17
25. 2a+9b+6c=17
26. 2a+11b+5c=18
27. 2a+9b+7c=18
28. 2a+8b+8c=18
29. 2a+10b+7c=19
30. 2a+11b+6c=19
31. 2a+12b+6c=20
32. 2a+10b+8c=20
33. 2a+11b+7c=20
34. 2a+11b+8c=21
35. 2a+12b+8c=22
36. 2a+12b+7c=21
37. 2a+13b+6c=21
38. 2a+13b+8c=23
39. 2a+13b+7c=22
40. 2a+14b+7c=23
41. 2a+14b+8c=24

No. 2. *Gr. alpicola* HEDW.

1. 2a+0b+2c=4
2. 2a+0b+3c=5
3. 2a+0b+4c=6
4. 2a+1b+4c=7
5. 2a+1b+5c=8
6. 2a+2b+5c=9
7. 2a+2b+6c=10
8. 2a+2b+7c=11
9. 2a+2b+8c=12
10. 2a+3b+7c=12
11. 2a+2b+9c=13
12. 2a+3b+8c=13
13. 2a+4b+8c=14
14. 2a+5b+8c=15
15. 2a+4b+9c=15
16. 2a+5b+9c=16
17. 2a+6b+8c=16
18. 2a+6b+9c=17

No. 2



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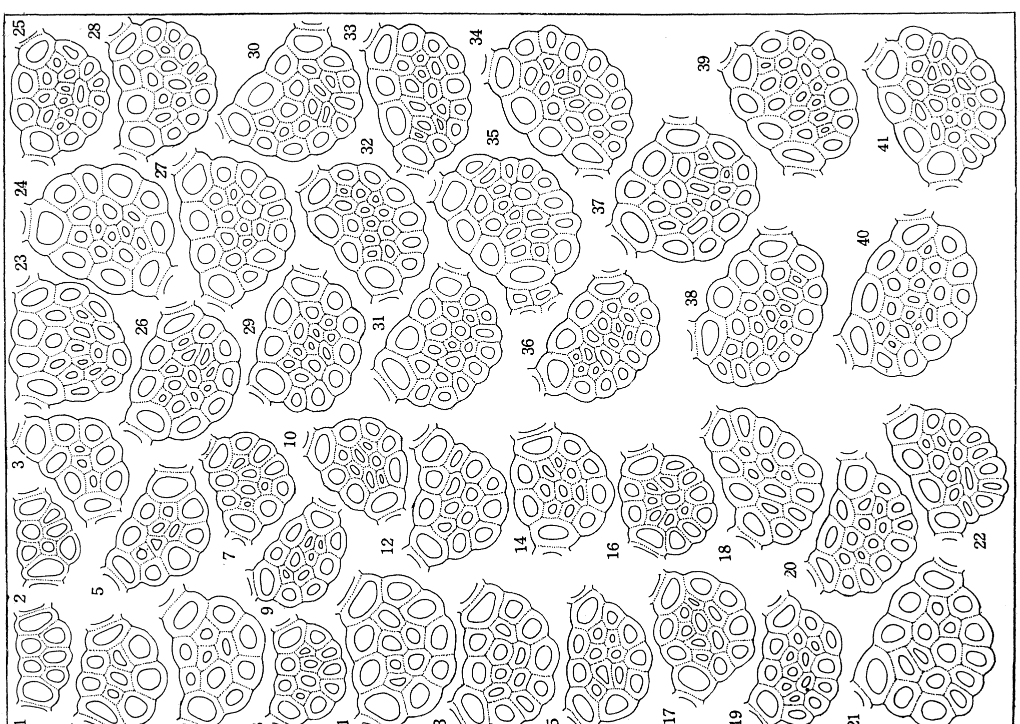


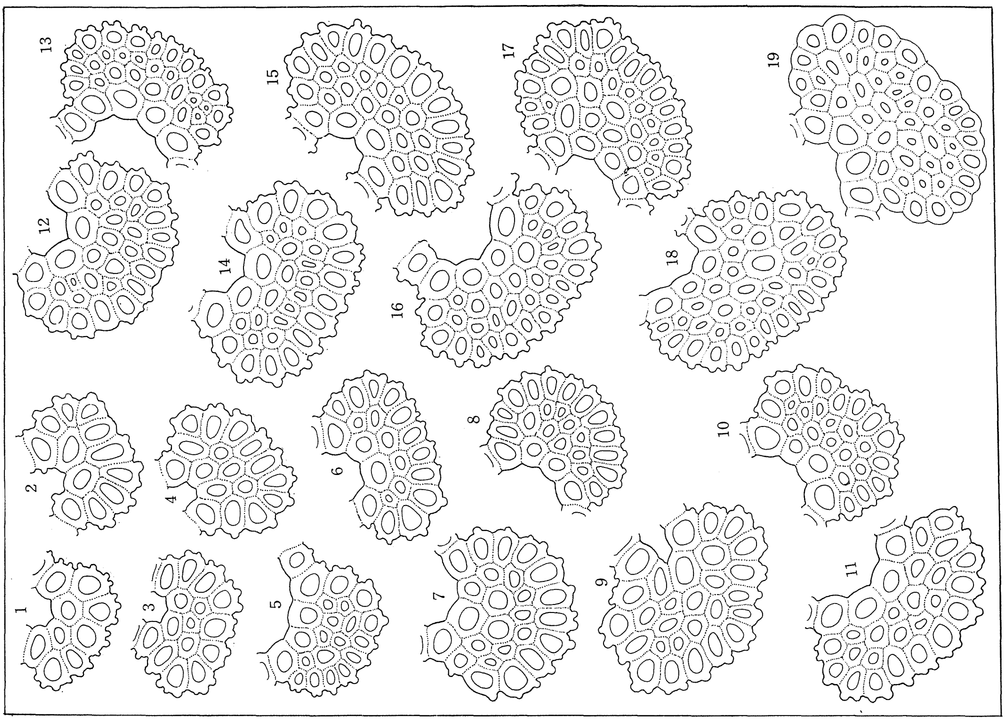
Plate II

No. 1. *Gr. anodon* B. S. G.

1.	2a+0b+3c=5	14.	3a+4b+8c=15
2.	2a+1b+3c=6	15.	3a+5b+7c=15
3.	2a+1b+4c=7	16.	3a+5b+8c=16
4.	2a+1b+5c=8	17.	4a+4b+8c=16
5.	2a+2b+5c=9	18.	4a+5b+8c=17
6.	2a+3b+5c=10	19.	5a+4b+8c=17
7.	2a+3b+6c=11	20.	5a+4b+9c=18
8.	3a+3b+5c=11	21.	5a+5b+8c=18
9.	2a+4b+6c=12	22.	6a+4b+8c=18
10.	2a+5b+5c=12	23.	6a+4b+9c=19
11.	2a+5b+6c=13	24.	6a+5b+8c=19
12.	3a+4b+6c=13	25.	6a+5b+9c=20
13.	3a+4b+7c=14	26.	7a+5b+9c=21

No. 2. *Gr. anomala* HAMPE

1.	2a+0b+5c=7
2.	2a+0b+8c=10
3.	2a+3b+8c=13
4.	2a+3b+10c=15
5.	2a+8b+9c=19
6.	2a+6b+11c=19
7.	2a+10b+11c=23
8.	2a+9b+12c=23
9.	2a+10b+14c=26
10.	2a+12b+12c=26
11.	2a+11b+13c=26
12.	2a+14b+14c=30
13.	2a+15b+13c=30
14.	2a+16b+13c=31
15.	2a+14b+15c=31
16.	2a+15b+15c=32
17.	2a+18b+17c=37
18.	2a+20b+18c=40
19.	2a+27b+19c=48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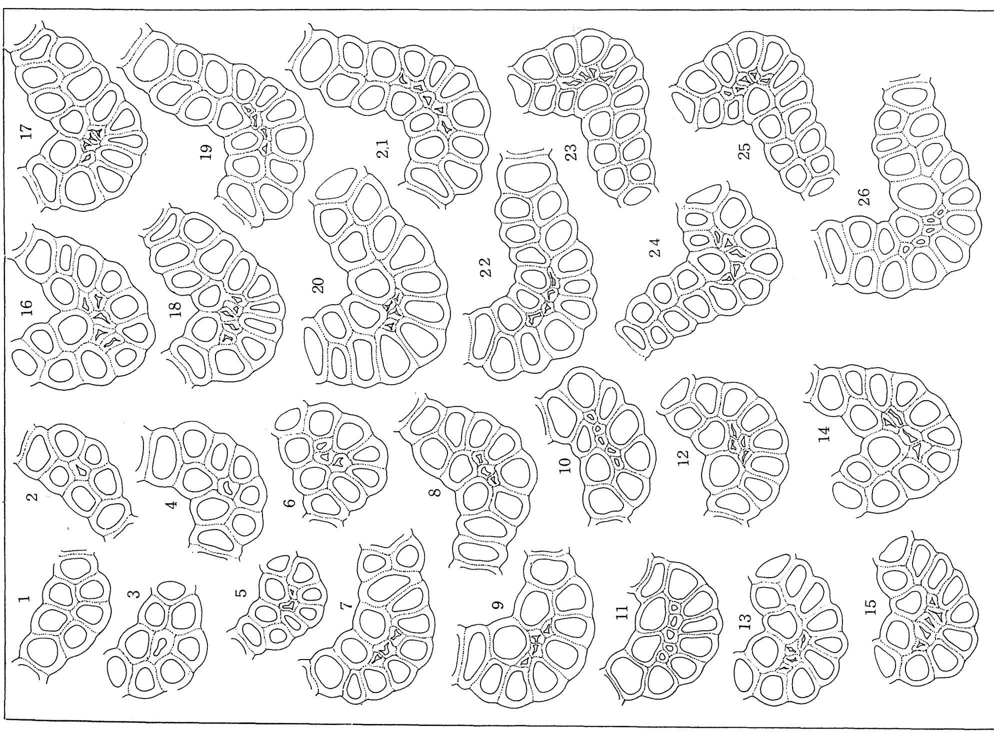
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No. 1

Plate III

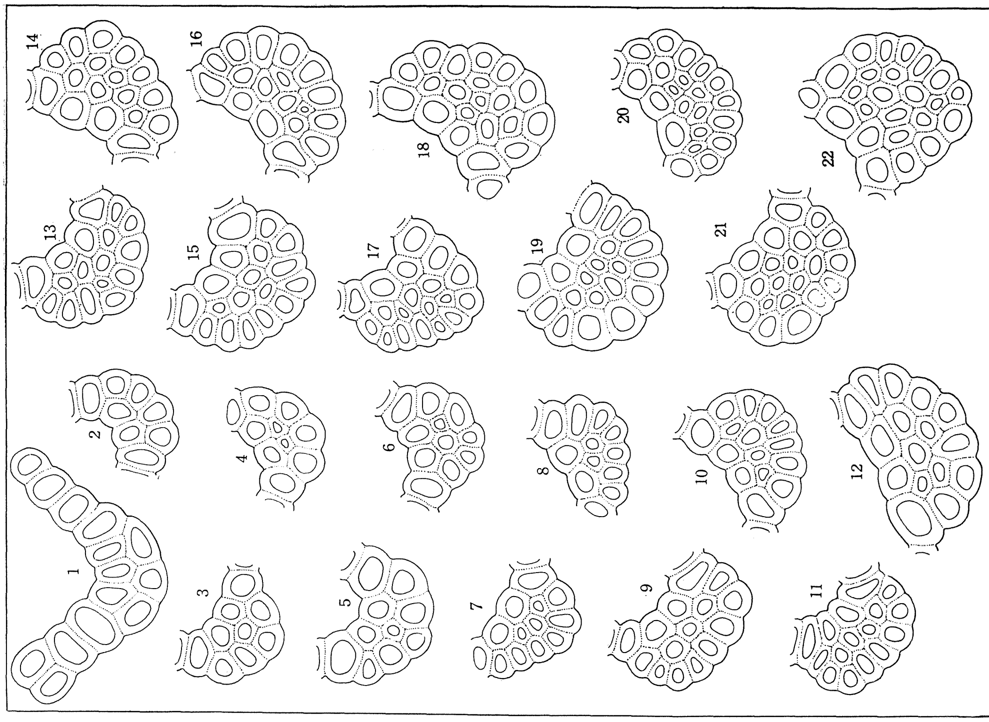
No. 1. *Gr. apocarpa* HEDW.

1. $2a+0b+4c=6$
2. $2a+1b+6c=9$
3. $2a+1b+7c=10$
4. $2a+2b+6c=10$
5. $2a+2b+7c=11$
6. $2a+3b+7c=12$
7. $2a+4b+9c=15$
8. $2a+5b+9c=16$
9. $2a+6b+9c=17$
10. $2a+6b+10c=18$
11. $2a+7b+10c=19$
12. $2a+8b+10c=20$
13. $2a+9b+11c=22$
14. $2a+10b+11c=23$
15. $2a+11b+11c=24$
16. $2a+12b+11c=25$
17. $2a+11b+12c=25$
18. $2a+12b+12c=26$

No. 2. *Gr. apocarpa* var. *atrofusca* (SCHIMP.) HUSN.

1. $2a+0b+3c=5$
2. $2a+0b+4c=6$
3. $2a+1b+4c=7$
4. $2a+2b+4c=8$
5. $2a+1b+5c=8$
6. $2a+2b+5c=9$
7. $2a+3b+6c=11$
8. $2a+2b+6c=10$
9. $2a+3b+8c=13$
10. $2a+4b+7c=13$
11. $2a+4b+8c=14$
12. $2a+5b+7c=14$
13. $2a+5b+8c=15$
14. $2a+6b+7c=15$
15. $2a+5b+9c=16$
16. $2a+6b+8c=16$
17. $2a+6b+9c=17$
18. $2a+8b+8c=18$
19. $2a+7b+9c=18$
20. $2a+8b+9c=19$
21. $2a+9b+8c=19$
22. $2a+10b+10c=22$

No. 2



No. 1

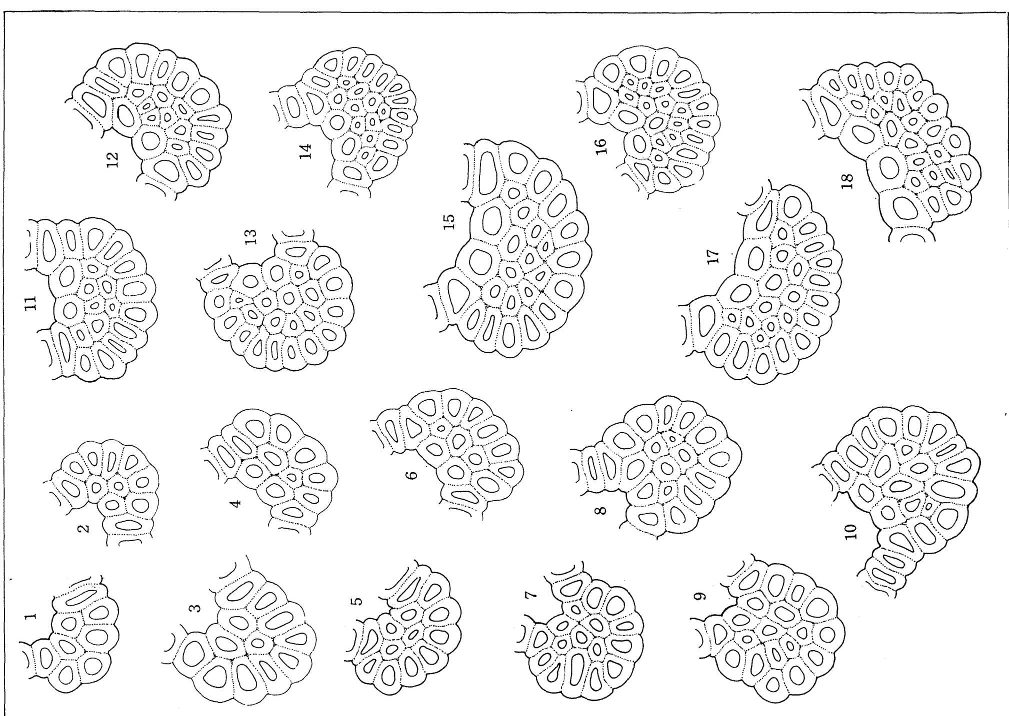


Plate IV

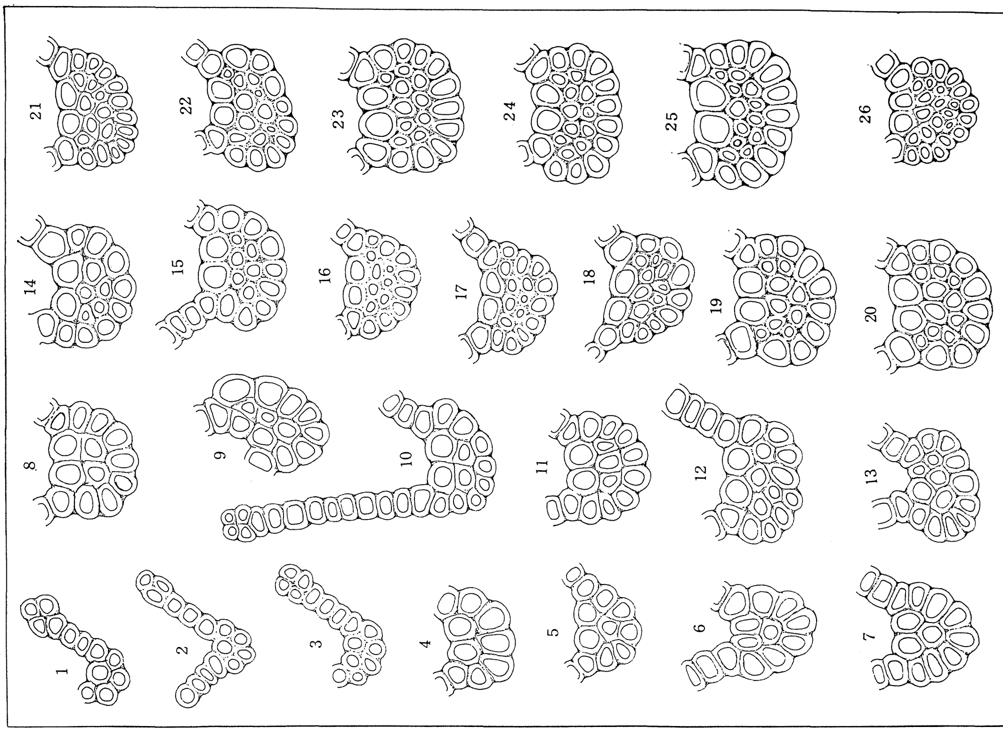
No. 1. *Gr. apocarpa* var. *conferta* (FUNCK) SPRENG.

1.	$1a+0b+3c=4$	17.	$2a+4b+8c=14$
2.	$2a+0b+5c=7$	18.	$2a+3b+9c=14$
3.	$2a+1b+6c=9$	19.	$2a+3b+10c=15$
4.	$2a+0b+7c=9$	20.	$2a+2b+11c=15$
5.	$2a+2b+5c=9$	21.	$2a+4b+9c=15$
6.	$2a+1b+7c=10$	22.	$2a+4b+10c=16$
7.	$2a+2b+7c=11$	23.	$2a+3b+11c=16$
8.	$2a+3b+6c=11$	24.	$2a+5b+10c=17$
9.	$2a+1b+8c=11$	25.	$2a+4b+11c=17$
10.	$2a+2b+8c=12$	26.	$2a+4b+12c=18$
11.	$2a+3b+7c=12$	27.	$2a+6b+10c=18$
12.	$2a+1b+9c=12$	28.	$2a+7b+10c=19$
13.	$2a+2b+9c=13$	29.	$2a+5b+12c=19$
14.	$2a+3b+8c=13$	30.	$2a+6b+12c=20$
15.	$2a+4b+7c=13$	31.	$2a+7b+12c=21$
16.	$2a+2b+10c=14$	32.	$2a+10b+12c=24$

No. 2. *Gr. apocarpa* var. *microtheca* CARD.

1.	$1a+0b+3c=4$	14.	$2a+5b+8c=15$
2.	$1a+0b+4c=5$	15.	$2a+6b+8c=16$
3.	$2a+0b+4c=6$	16.	$2a+7b+8c=17$
4.	$2a+0b+5c=7$	17.	$2a+7b+9c=18$
5.	$2a+1b+5c=8$	18.	$2a+8b+8c=18$
6.	$2a+1b+6c=9$	19.	$2a+9b+8c=19$
7.	$2a+1b+7c=10$	20.	$2a+10b+8c=20$
8.	$2a+2b+7c=11$	21.	$2a+8b+11c=21$
9.	$2a+3b+7c=12$	22.	$2a+10b+9c=21$
10.	$2a+2b+8c=12$	23.	$2a+10b+10c=22$
11.	$2a+3b+8c=13$	24.	$2a+11b+10c=23$
12.	$2a+4b+8c=14$	25.	$2a+12b+10c=24$
13.	$2a+3b+9c=14$	26.	$2a+12b+11c=25$

No. 2



No. 1

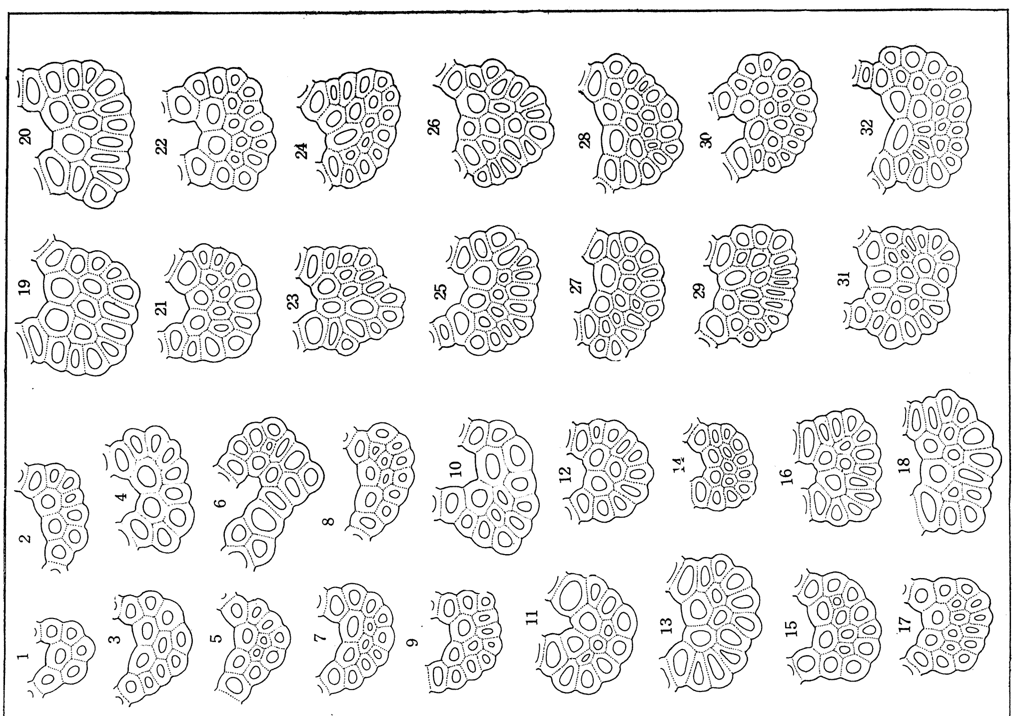


Plate V

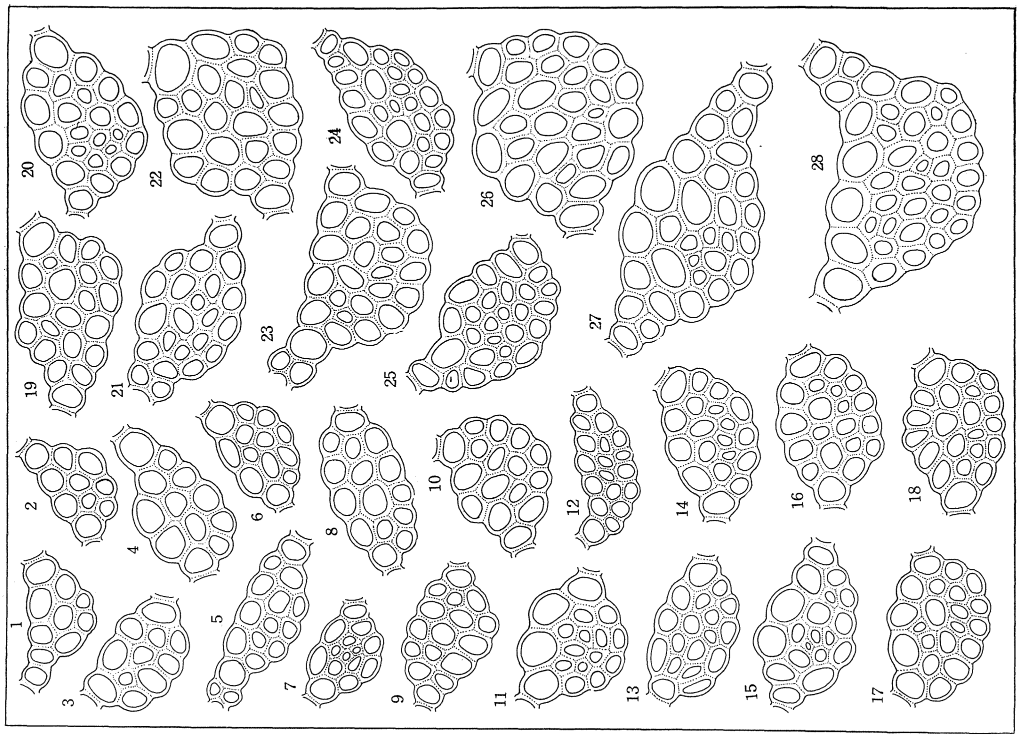
No. 1. *Gr. apocarpa* var. *rivularis* (BRID.) NEES et HORNSCH.

1. 1a+0b+2c=3
2. 2a+1b+2c=5
3. 2a+1b+3c=6
4. 2a+2b+3c=7
5. 2a+2b+4c=8
6. 2a+3b+4c=9
7. 2a+3b+5c=10
8. 2a+4b+5c=11
9. 2a+3b+6c=11
10. 2a+5b+6c=13
11. 2a+6b+6c=14
12. 2a+7b+6c=15
13. 2a+6b+7c=15
14. 2a+5b+8c=15
15. 2a+7b+7c=16
16. 2a+7b+8c=17
17. 2a+8b+7c=17
18. 2a+8b+8c=18
19. 2a+10b+7c=19
20. 2a+10b+8c=20
21. 2a+10b+8c=20

No. 2. *Gr. apocarpa* var. *rivularis* f. *acutifolia* (T. JENS.)

1. 2a+1b+4c=7
2. 2a+2b+4c=8
3. 2a+3b+4c=9
4. 3a+2b+5c=10
5. 4a+3b+5c=12
6. 3a+4b+5c=12
7. 2a+6b+5c=13
8. 4a+4b+5c=13
9. 5a+4b+5c=14
10. 3a+5b+6c=14
11. 2a+8b+5c=15
12. 5a+4b+7c=16
13. 3a+8b+5c=16
14. 3a+8b+6c=17
15. 4a+8b+5c=17
16. 4a+8b+6c=18
17. 3a+9b+7c=19
18. 5a+8b+6c=19
19. 5a+7b+7c=19
20. 4a+10b+6c=20
21. 6a+8b+7c=21
22. 5a+9b+7c=21
23. 4a+10b+8c=22
24. 6a+9b+8c=23
25. 5a+12b+8c=25
26. 4a+14b+8c=26
27. 7a+11b+10c=28
28. 5a+18b+12c=35

No. 2



No. 1

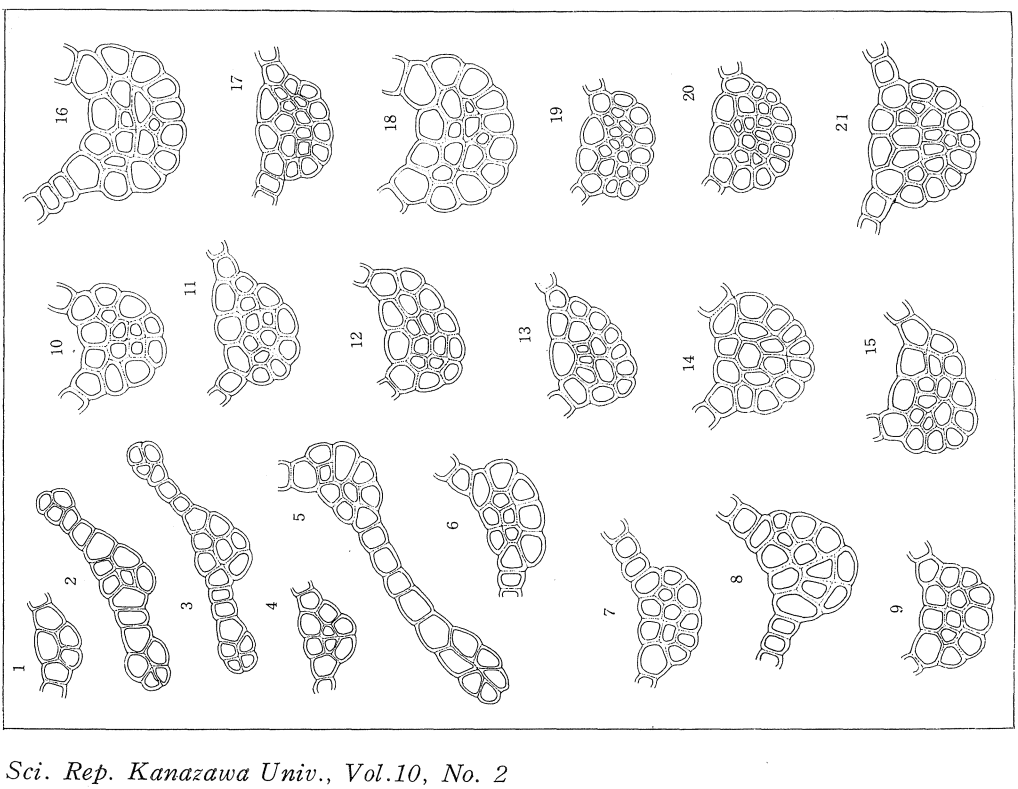


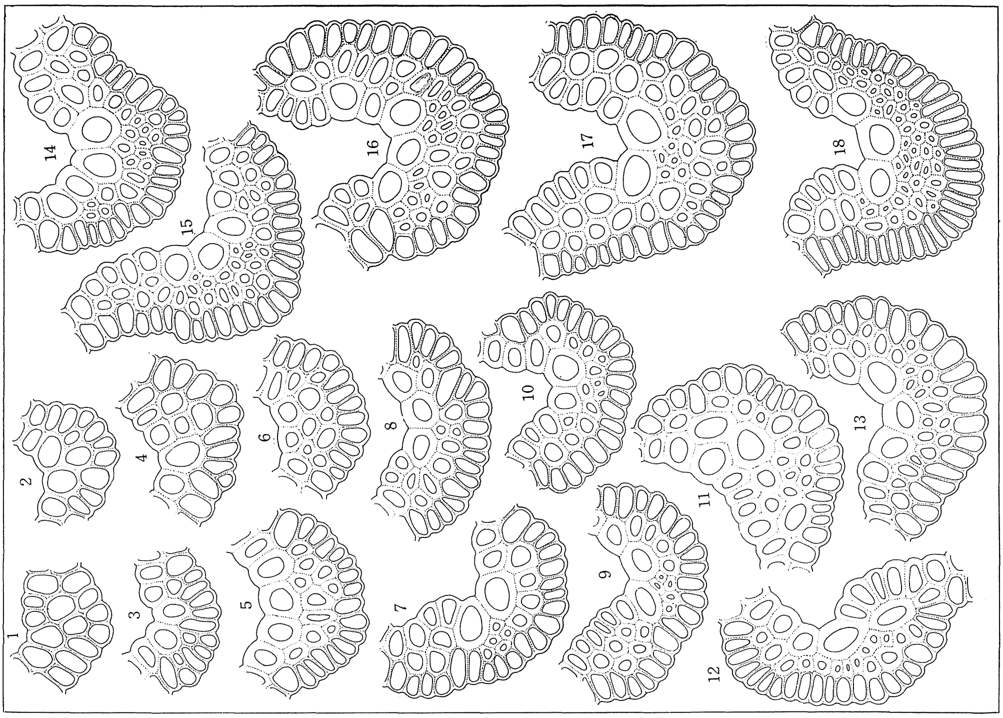
Plate VI

No. 1. *Gr. apocarpa* var. *tenerrima* Nees et Hornsch.

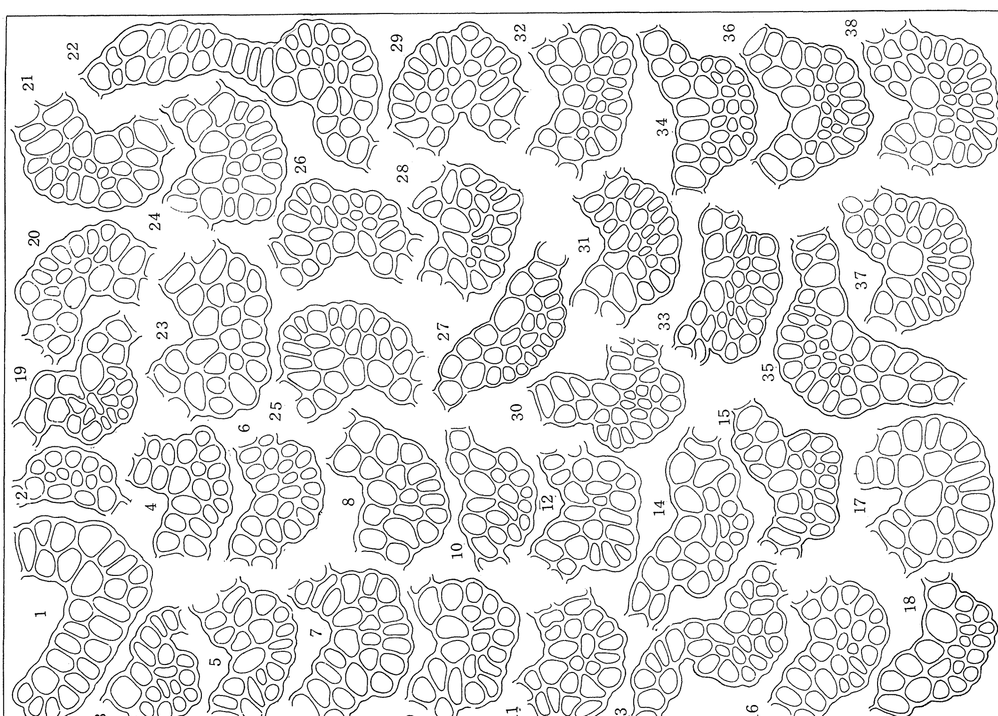
1. 2a+1b+6c=9
2. 2a+4b+5c=11
3. 2a+4b+7c=13
4. 3a+2b+9c=14
5. 4a+2b+9c=15
6. 3a+4b+7c=14
7. 3a+4b+9c=16
8. 4a+3b+9c=16
9. 3a+4b+10c=17
10. 4a+4b+8c=16
11. 3a+5b+9c=17
12. 4a+3b+10c=17
13. 4a+4b+9c=17
14. 4a+4b+10c=18
15. 3a+6b+9c=18
16. 4a+5b+9c=18
17. 4a+6b+9c=19
18. 4a+3b+11c=18
19. 4a+5b+10c=19
20. 4a+4b+11c=19
21. 4a+6b+10c=20
22. 4a+7b+10c=21
23. 4a+5b+12c=21
24. 5a+6b+10c=21
25. 4a+6b+12c=22
26. 4a+6b+11c=21
27. 4a+6b+13c=23
28. 4a+7b+11c=22
29. 5a+7b+11c=23
30. 4a+7b+12c=23
31. 5a+8b+11c=24
32. 5a+7b+12c=24
33. 5a+9b+12c=26
34. 4a+9b+13c=26
35. 5a+11b+12c=28
36. 6a+12b+12c=30
37. 6a+10b+14c=30
38. 6a+13b+15c=34

No. 2. *Gr. arizonae* Ren. et Card.

1. 2a+2b+5c=9
2. 2a+2b+9c=13
3. 3a+4b+11c=18
4. 3a+2b+10c=15
5. 3a+10b+16c=29
6. 3a+7b+12c=22
7. 4a+10b+19c=33
8. 6a+12b+20c=38
9. 5a+13b+21c=39
10. 7a+15b+19c=41
11. 6a+16b+20c=42
12. 8a+16b+21c=45
13. 6a+23b+22c=51
14. 7a+23b+25c=55
15. 9a+30b+26c=65
16. 10a+31b+30c=71
17. 11a+33b+33c=77
18. 11a+47b+36c=96



No. 2



No. 1

Plate VII

No. 1. *Gr. cratericola* SAK. et TAK.

1. 2a+0b+3c=5
2. 2a+0b+4c=6
3. 2a+0b+5c=7
4. 2a+1b+5c=8
5. 3a+1b+5c=9
6. 3a+1b+6c=10
7. 3a+1b+7c=11
8. 4a+1b+6c=11
9. 4a+1b+7c=12
10. 4a+2b+6c=12
11. 4a+1b+8c=13
12. 3a+3b+7c=13
13. 4a+2b+7c=13
14. 4a+2b+8c=14
15. 3a+4b+7c=14
16. 4a+3b+7c=14
17. 5a+2b+8c=15
18. 3a+3b+9c=15
19. 4a+2b+10c=16
20. 4a+3b+9c=16
21. 5a+3b+9c=17
22. 5a+2b+11c=18
23. 5a+3b+10c=18
24. 5a+4b+9c=18
25. 6a+3b+11c=20
26. 6a+3b+10c=19
27. 4a+6b+9c=19
28. 4a+6b+10c=20
29. 5a+4b+11c=20
30. 4a+6b+11c=21
31. 6a+4b+11c=21
32. 6a+6b+11c=23
33. 5a+6b+10c=21
34. 6a+6b+14c=26
35. 6a+6b+12c=24
36. 6a+7b+14b=27

No. 2. *Gr. decalvata* CARD.

1. 1a+0b+3c=4
2. 2a+0b+3c=5
3. 2a+0b+4c=6
4. 2a+0b+5c=7
5. 2a+1b+5c=8
6. 2a+1b+6c=9
7. 2a+2b+6c=10
8. 2a+2b+7c=11
9. 2a+3b+7c=12
10. 2a+4b+7c=13
11. 2a+5b+8c=15
12. 2a+5b+9c=16
13. 2a+5b+10c=17
14. 2a+6b+10c=18
15. 2a+7b+10c=19
16. 2a+7b+11c=20
17. 2a+8b+11c=21
18. 2a+9b+11c=22
19. 2a+9b+12c=23
20. 2a+9b+13c=24
21. 2a+10b+13c=25
22. 2a+11b+13c=26
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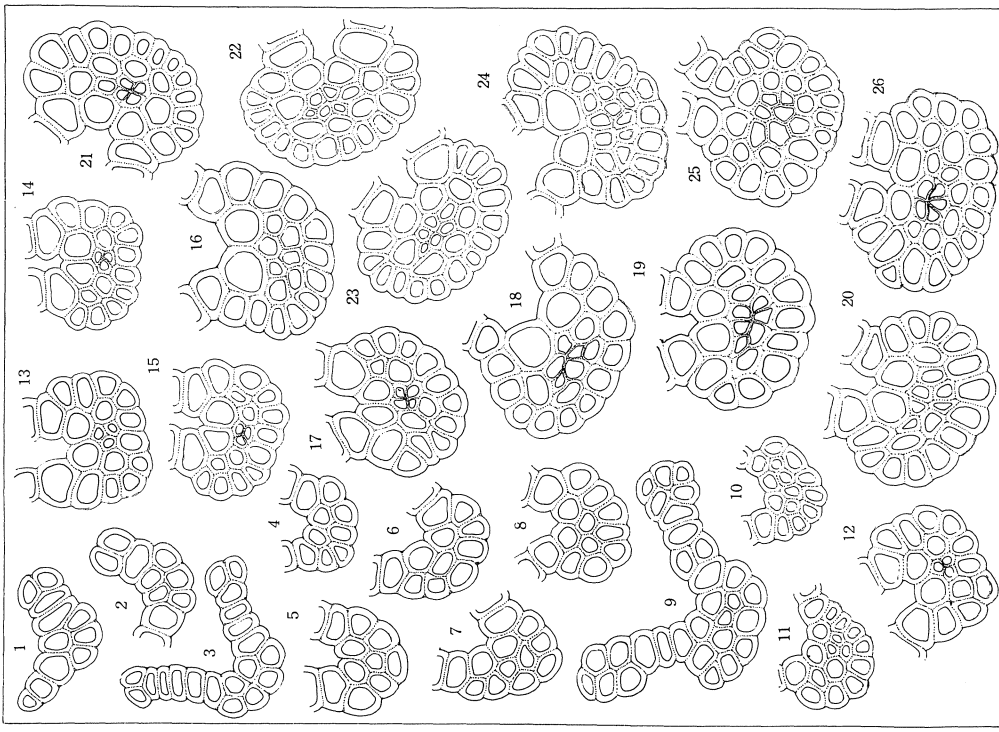
24. 2a+12b+14c=28
25. 2a+12b+15c=29
26. 2a+13b+15c=30



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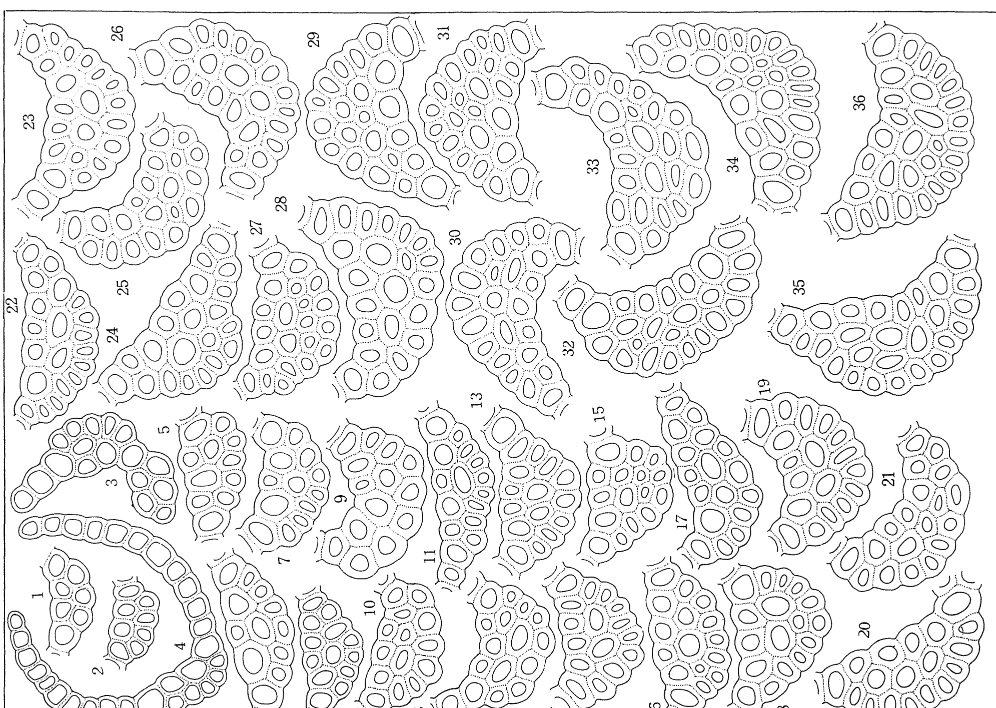


No. 1

Plate VIII

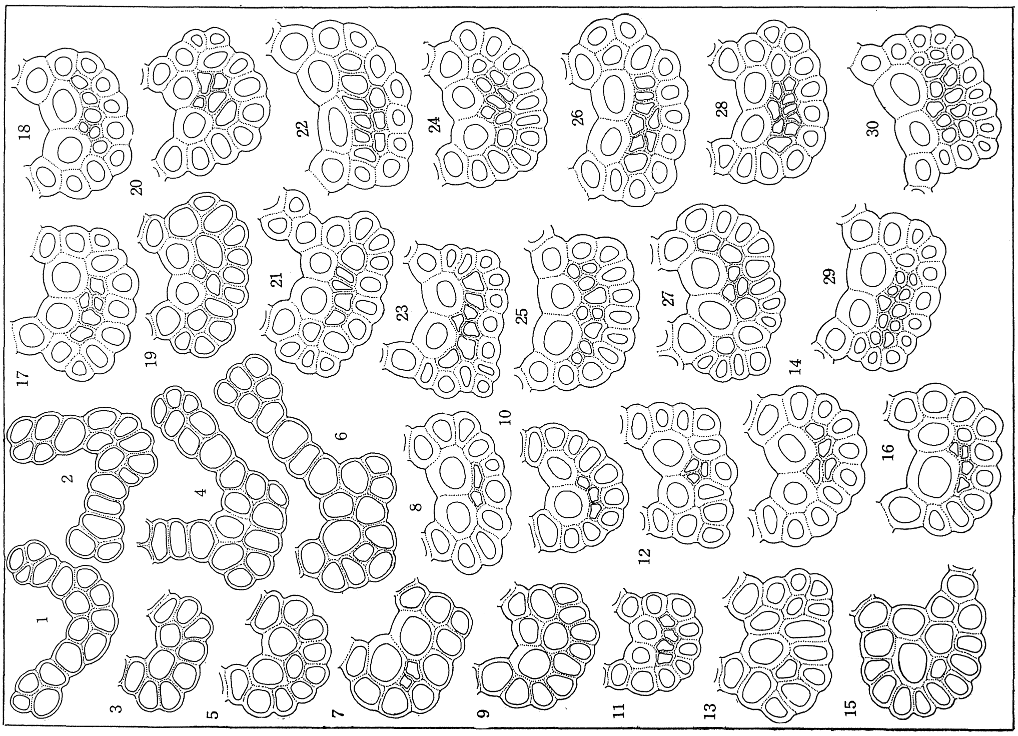
No. 1. *Gr. decipiens* (Schultz.) Lindb.

1. $4a+0b+9c=13$
2. $4a+0b+12c=16$
3. $4a+0b+15c=19$
4. $4a+3b+15c=22$
5. $5a+6b+14c=25$
6. $5a+7b+17c=29$
7. $6a+6b+19c=31$
8. $5a+10b+17c=32$
9. $6a+7b+20c=33$
10. $5a+13b+18c=36$
11. $6a+14b+20c=40$
12. $6a+16b+21c=43$
13. $7a+16b+21c=44$
14. $6a+18b+21c=45$
15. $7a+20b+21c=48$

No. 2. *Gr. donniana* Sm.

1. $2a+0b+4c=8$
2. $2a+0b+5c=9$
3. $2a+0b+6c=8$
4. $2a+0b+7c=9$
5. $2a+1b+7c=10$
6. $2a+1b+8c=11$
7. $2a+2b+7c=11$
8. $2a+2b+8c=12$
9. $2a+1b+9c=12$
10. $2a+3b+7c=12$
11. $2a+4b+7c=13$
12. $2a+3b+9c=14$
13. $2a+2b+10c=14$
14. $2a+4b+8c=14$
15. $2a+3b+10c=15$
16. $2a+5b+8c=15$
17. $2a+5b+9c=16$
18. $2a+6b+8c=16$
19. $2a+4b+11c=17$
20. $2a+5b+10c=17$
21. $2a+6b+11c=19$
22. $2a+9b+8c=19$
23. $2a+7b+11c=20$
24. $2a+8b+10c=20$
25. $2a+9b+9c=20$
26. $2a+9b+10c=21$
27. $2a+7b+13c=22$
28. $2a+10b+10c=22$
29. $2a+11b+10c=23$
30. $2a+11b+11c=24$

No. 2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No .1

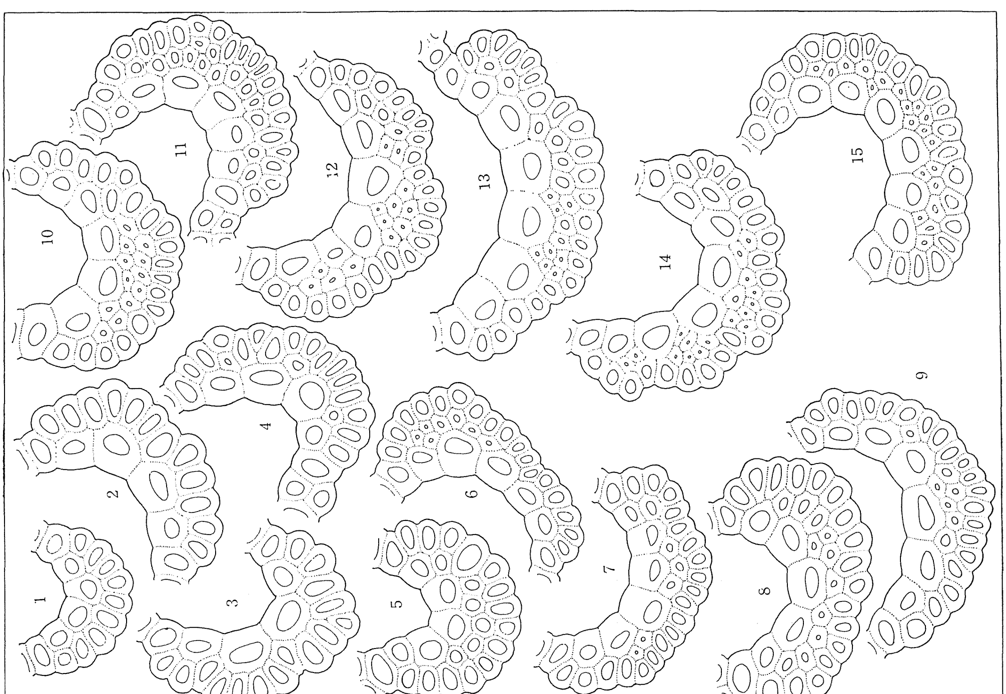
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Plate IX

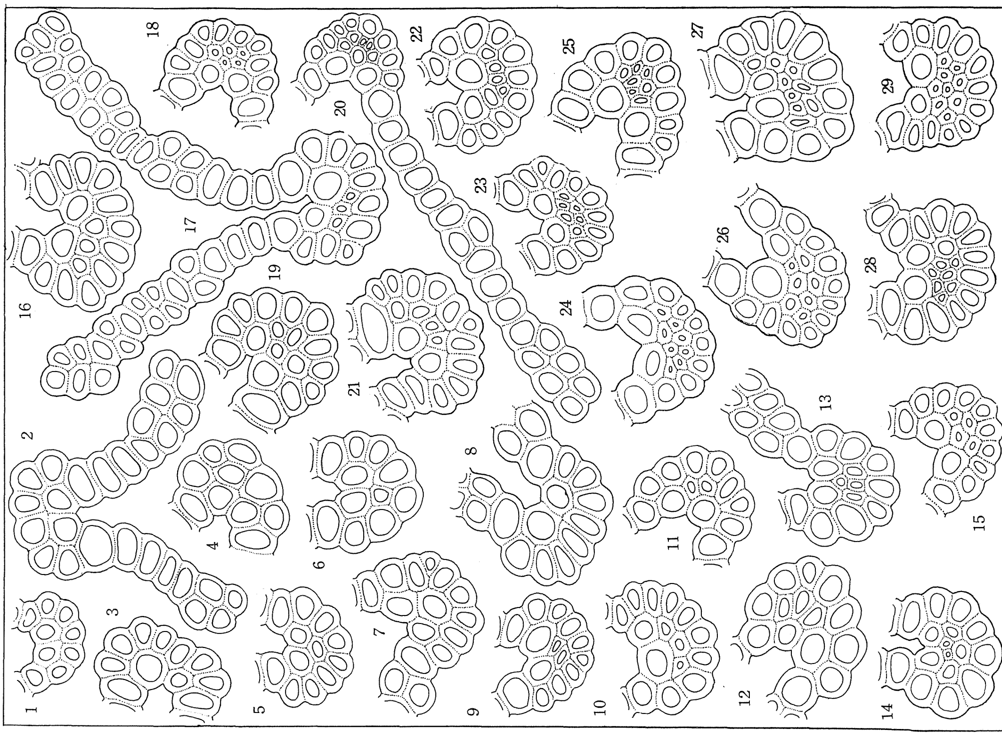
No. 1. *Gr. elatior* BRUCH

1. 2a+1b+7c=10
2. 2a+0b+5c=7
3. 2a+0b+8c=10
4. 2a+2b+7c=11
5. 2a+3b+7c=12
6. 2a+3b+10c=15
7. 2a+4b+10c=16
8. 2a+5b+9c=16
9. 2a+4b+11c=17
10. 2a+6b+10c=18
11. 2a+5b+11c=18
12. 2a+7b+10c=19
13. 2a+8b+11c=21
14. 2a+9b+11c=22
15. 2a+8b+12c=22
16. 2a+9b+12c=23
17. 2a+11b+11c=24
18. 2a+12b+11c=25
19. 2a+12b+12c=26
20. 2a+13b+12c=27
21. 2a+14b+12c=28

No. 2. *Gr. funalis* (SCHWAEGR.) B. S. G.

1. 2a+0b+5c=7
2. 2a+0b+6c=8
3. 2a+0b+7c=9
4. 2a+1b+5c=8
5. 2a+1b+7c=10
6. 2a+1b+6c=9
7. 2a+1b+8c=11
8. 2a+0b+8c=10
9. 2a+2b+8c=12
10. 2a+3b+8c=13
11. 2a+2b+7c=11
12. 2a+3b+7c=12
13. 2a+4b+7c=13
14. 2a+5b+7c=14
15. 2a+4b+8c=14
16. 2a+3b+10c=15
17. 2a+3b+9c=14
18. 2a+5b+8c=15
19. 2a+4b+9c=15
20. 2a+4b+10c=16
21. 2a+6b+8c=16
22. 2a+5b+9c=16
23. 2a+6b+9c=17
24. 2a+8b+8c=18
25. 2a+7b+8c=17
26. 2a+7b+10c=19
27. 2a+9b+9c=20
28. 2a+8b+10c=20
29. 2a+9b+10c=21

No. 2



No. 1

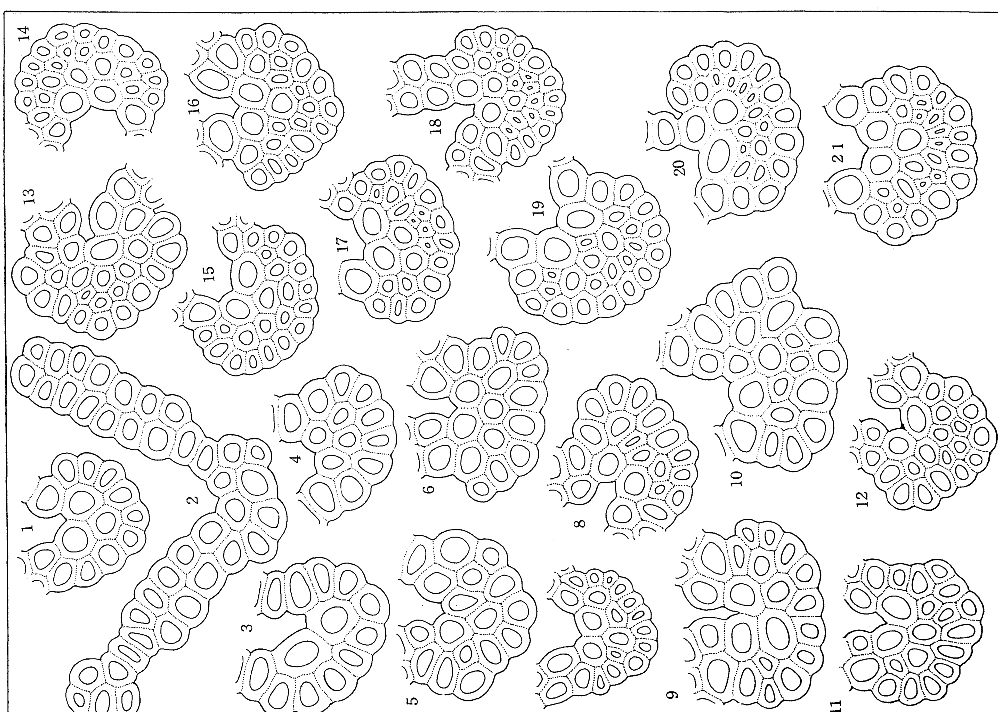


Plate X

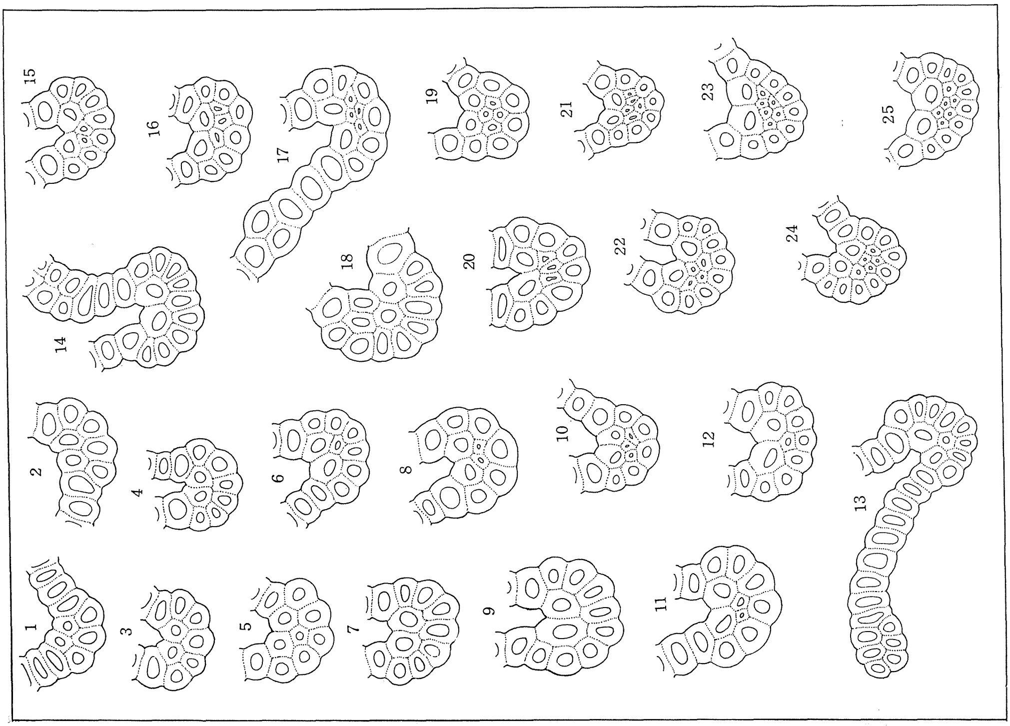
No. 1. *Gr. funalis* var. *calvescens* (KINDB.) MOELL.

1. 1a+0b+3c=4
2. 2a+0b+3c=5
3. 2a+0b+4c=6
4. 2a+1b+4c=7
5. 2a+0b+5c=7
6. 2a+0b+6c=8
7. 3a+0b+5c=8
8. 2a+0b+7c=9
9. 2a+1b+5c=8
10. 3a+0b+6c=9
11. 2a+1b+7c=10
12. 3a+1b+6c=10
13. 3a+0b+7c=10
14. 3a+1b+7c=11
15. 3a+2b+6c=11
16. 3a+2b+7c=12
17. 3a+1b+8c=12
18. 4a+0b+8c=12
19. 4a+1b+7c=12
20. 3a+1b+9c=13
21. 4a+0b+8c=12
22. 4a+1b+8c=13
23. 4a+0b+9c=13
24. 3a+2b+8c=13
25. 4a+1b+9c=14
26. 4a+0b+10c=14
27. 5a+0b+9c=14
28. 5a+0b+10c=15
29. 4a+1b+10c=15
30. 5a+1b+10c=16
31. 5a+2b+12c=19

No. 2. *Gr. funalis* f. *longipila* BOUL.

1. 2a+0b+3c=5
2. 2a+0b+4c=6
3. 2a+0b+5c=7
4. 2a+0b+6c=8
5. 2a+1b+5c=8
6. 2a+1b+6c=9
7. 2a+0b+7c=9
8. 2a+2b+5c=9
9. 2a+0b+8c=10
10. 2a+3b+5c=10
11. 2a+2b+6c=10
12. 2a+1b+7c=10
13. 2a+1b+8c=11
14. 2a+0b+9c=11
15. 2a+2b+7c=11
16. 2a+3b+6c=11
17. 2a+4b+6c=12
18. 2a+2b+8c=12
19. 2a+5b+5c=12
20. 2a+3b+7c=12
21. 2a+5b+6c=13
22. 2a+4b+8c=14
23. 2a+6b+7c=15
24. 2a+5b+8c=15
25. 2a+6b+8c=16

No. 2



No. 1

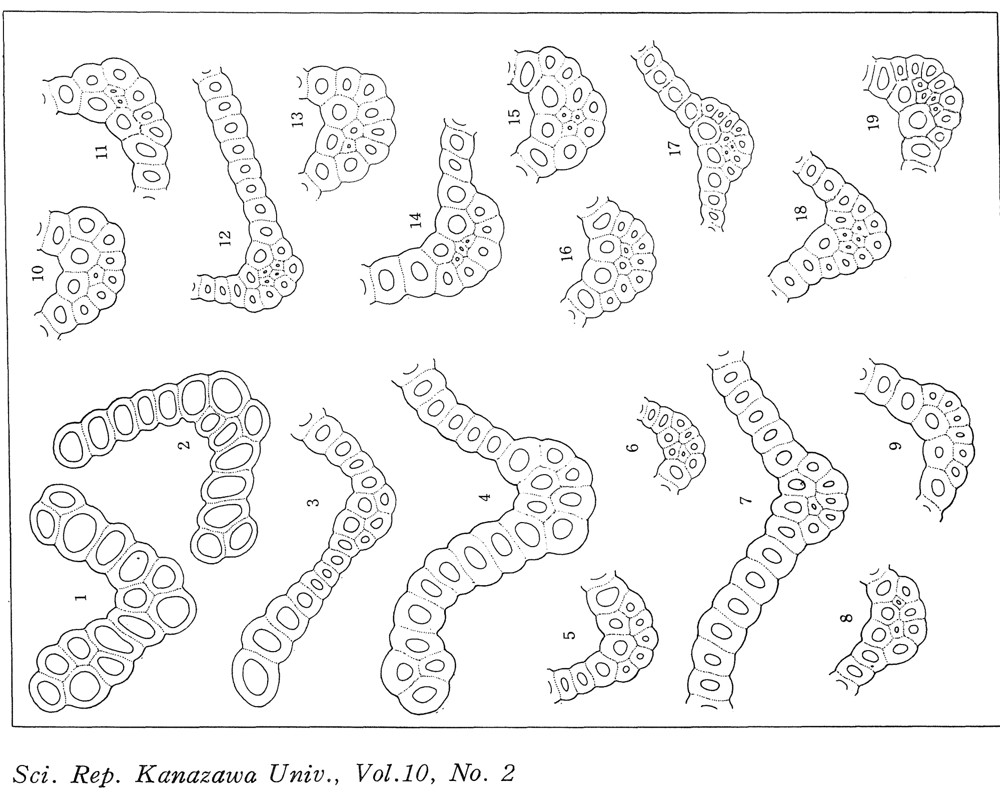


Plate XI

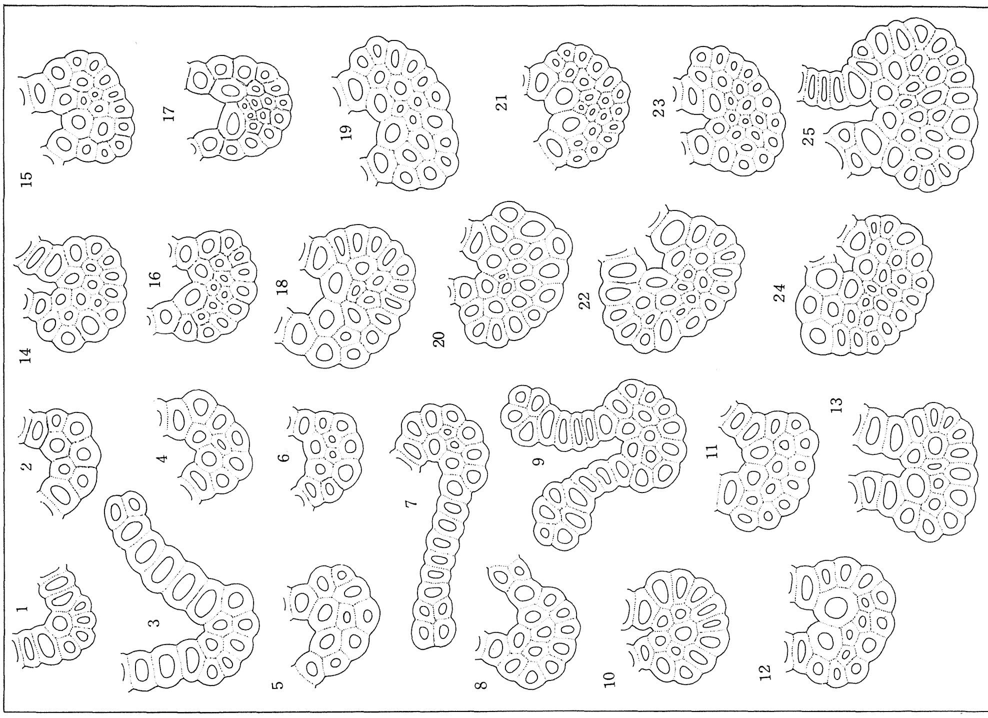
No. 1. *Gr. hartmanii* SCHIMP.

1. 2a+0b+7c=9
2. 2a+0b+8c=10
3. 2a+1b+9c=12
4. 2a+1b+10c=13
5. 2a+2b+9c=13
6. 3a+1b+10c=14
7. 2a+2b+10c=14
8. 3a+3b+9c=15
9. 3a+3b+11c=17
10. 4a+3b+11c=18
11. 3a+3b+12c=18
12. 4a+3b+12c=19
13. 4a+4b+13c=21
14. 4a+3b+14c=21
15. 4a+5b+14c=23
16. 4a+11b+16c=31
17. 4a+14b+16c=34
18. 4a+15b+16c=35
19. 4a+17b+16c=37
20. 4a+18b+16c=38

No. 2. *Gr. incurva* SCHWAEGR.

1. 1a+0b+4c=5
2. 2a+0b+4c=6
3. 2a+0b+5c=7
4. 2a+1b+5c=8
5. 2a+1b+6c=9
6. 2a+2b+5c=9
7. 2a+2b+6c=10
8. 2a+2b+7c=11
9. 2a+3b+8c=13
10. 2a+3b+9c=14
11. 2a+4b+8c=14
12. 2a+4b+9c=15
13. 2a+4b+10c=16
14. 2a+5b+9c=16
15. 2a+5b+10c=17
16. 2a+6b+9c=17
17. 2a+7b+9c=18
18. 2a+6b+11c=19
19. 2a+7b+11c=20
20. 2a+8b+11c=21
21. 2a+9b+11c=22
22. 2a+9b+12c=23
23. 2a+10b+12c=24
24. 2a+11b+13c=26
25. 2a+11b+15c=28

No. 2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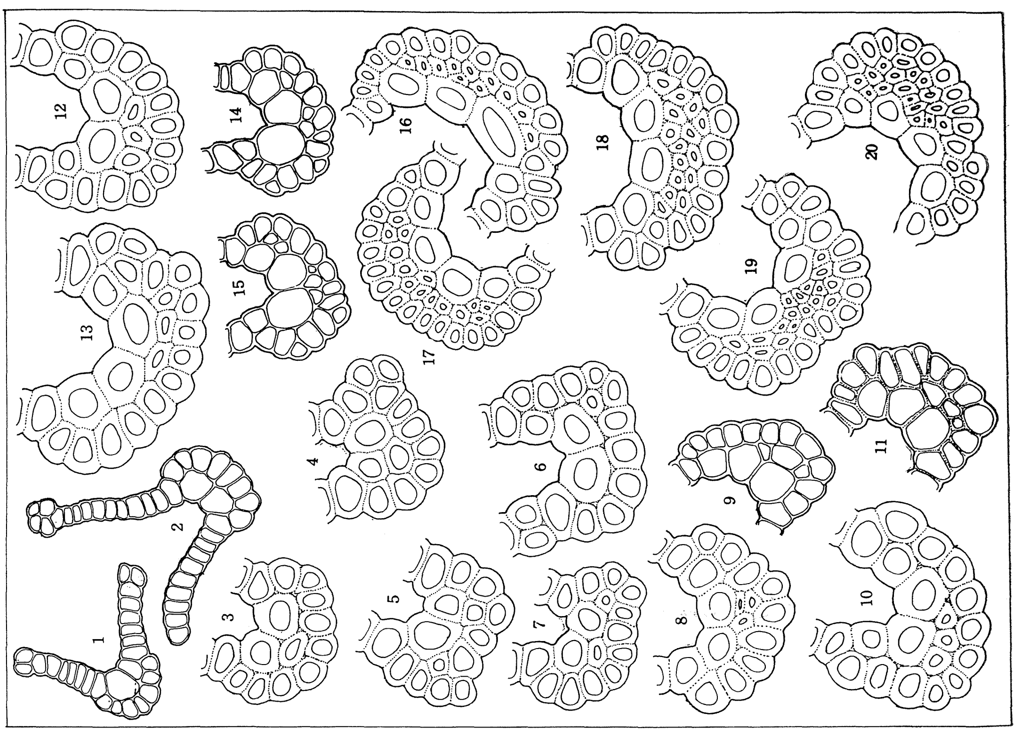
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Plate XII

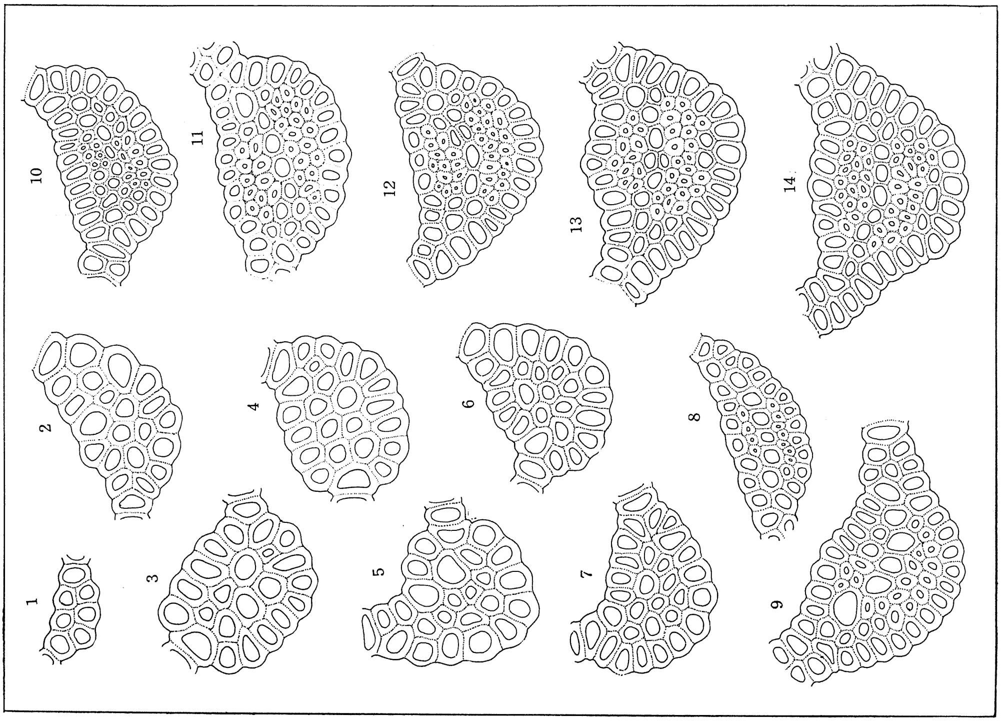
No. 1. *Gr. laevigata* (BRID.) BRID.

1. 2a+0b+5c=7
2. 2a+1b+6c=9
3. 2a+3b+6c=11
4. 2a+2b+7c=11
5. 3a+3b+6c=12
6. 3a+3b+8c=14
7. 4a+4b+8c=16
8. 4a+6b+8c=18
9. 4a+8b+8c=20
10. 5a+7b+8c=20
11. 4a+8b+10c=22
12. 7a+6b+11c=24
13. 5a+10b+9c=24
14. 4a+11b+11c=26
15. 8a+7b+11c=26
16. 5a+11b+11c=27
17. 7a+8b+12c=27
18. 6a+11b+11c=28
19. 8a+7b+14c=29
20. 7a+10b+13c=30
21. 7a+11b+12c=30
22. 6a+12b+13c=31
23. 7a+11b+13c=31
24. 8a+10b+13c=31
25. 9a+9b+15c=33
26. 8a+11b+14c=33
27. 8a+12b+15c=35
28. 9a+13b+14c=36
29. 9a+12b+16c=37
30. 9a+13b+16c=38
31. 9a+13b+18c=40

No. 2. *Gr. maritima* TURN.

1. 2a+0b+3c=5
2. 6a+6b+9c=21
3. 5a+7b+9c=21
4. 6a+8b+9c=23
5. 6a+9b+9c=24
6. 6a+9b+10c=25
7. 6a+10b+12c=28
8. 8a+18b+13c=39
9. 10a+29b+15c=54
10. 10a+33b+14c=57
11. 10a+39b+15c=64
12. 10a+45b+16c=71
13. 10a+47b+18c=75
14. 11a+54b+18c=82

No. 2



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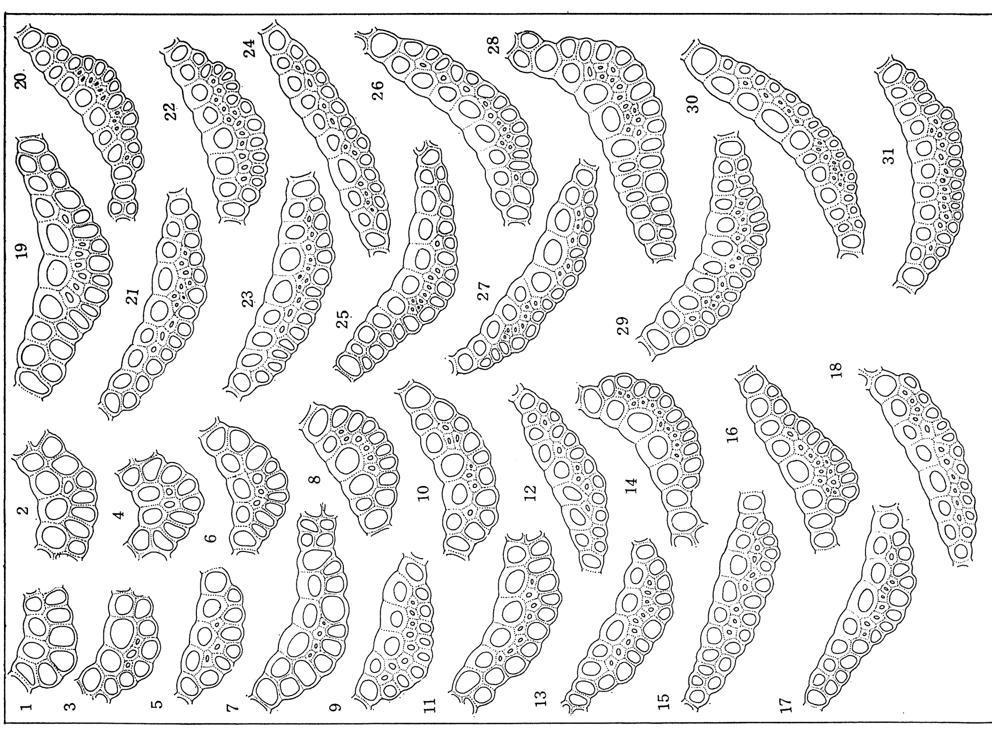


P l a t e XIII

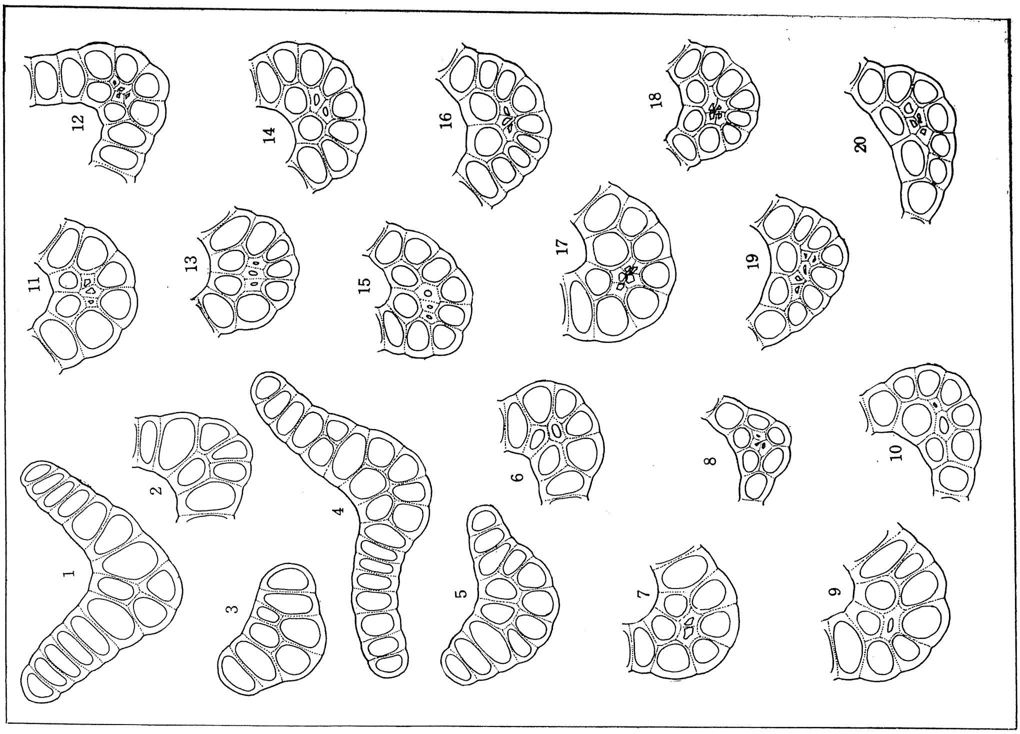
No. 1. *Gr. mollis* B. S. G.

1. 1a+0b+2c=3
2. 1a+0b+3c=4
3. 1a+0b+4c=5
4. 2a+0b+4c=6
5. 2a+1b+4c=7
6. 2a+2b+4c=8
7. 2a+3b+4c=9
8. 2a+2b+5c=9
9. 2a+4b+4c=10
10. 2a+4b+5c=11
11. 3a+4b+4c=11
12. 3a+4b+5c=12
13. 3a+4b+6c=13
14. 4a+4b+5c=13
15. 3a+5b+5c=13
16. 4a+5b+6c=15
17. 4a+6b+7c=17
18. 4a+6b+8c=18
19. 4a+7b+8c=19
20. 4a+8b+8c=20
21. 4a+10b+8c=22
22. 4a+11b+8c=23
23. 4a+12b+8c=24

No. 2. *Gr. orbicularis* var. *persica* SCHIFFNER

1. 1a+0b+2c=3
2. 1a+0b+3c=4
3. 2a+0b+2c=4
4. 2a+0b+4c=6
5. 2a+0b+5c=7
6. 2a+1b+4c=7
7. 2a+2b+4c=8
8. 2a+3b+3c=8
9. 2a+1b+5c=8
10. 2a+2b+5c=9
11. 2a+3b+4c=9
12. 2a+4b+4c=10
13. 2a+3b+5c=10
14. 2a+2b+6c=10
15. 2a+3b+6c=11
16. 2a+3b+7c=12
17. 2a+5b+5c=12
18. 2a+4b+6c=12
19. 2a+5b+6c=13
20. 2a+4b+7c=13

No. 2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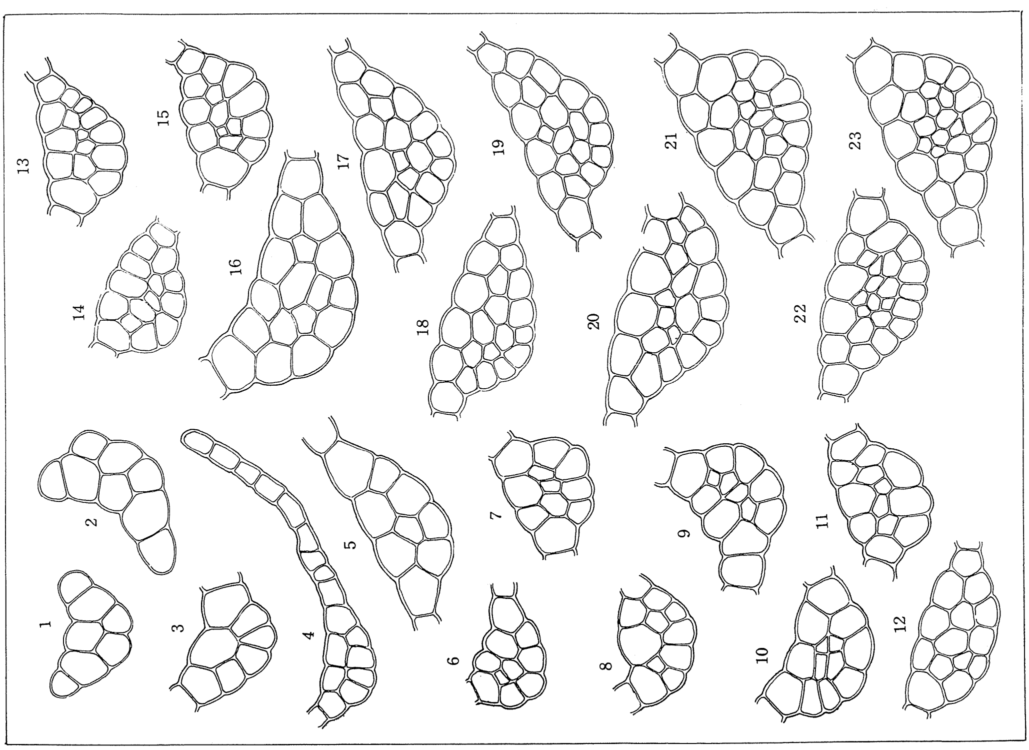
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Plate XIV

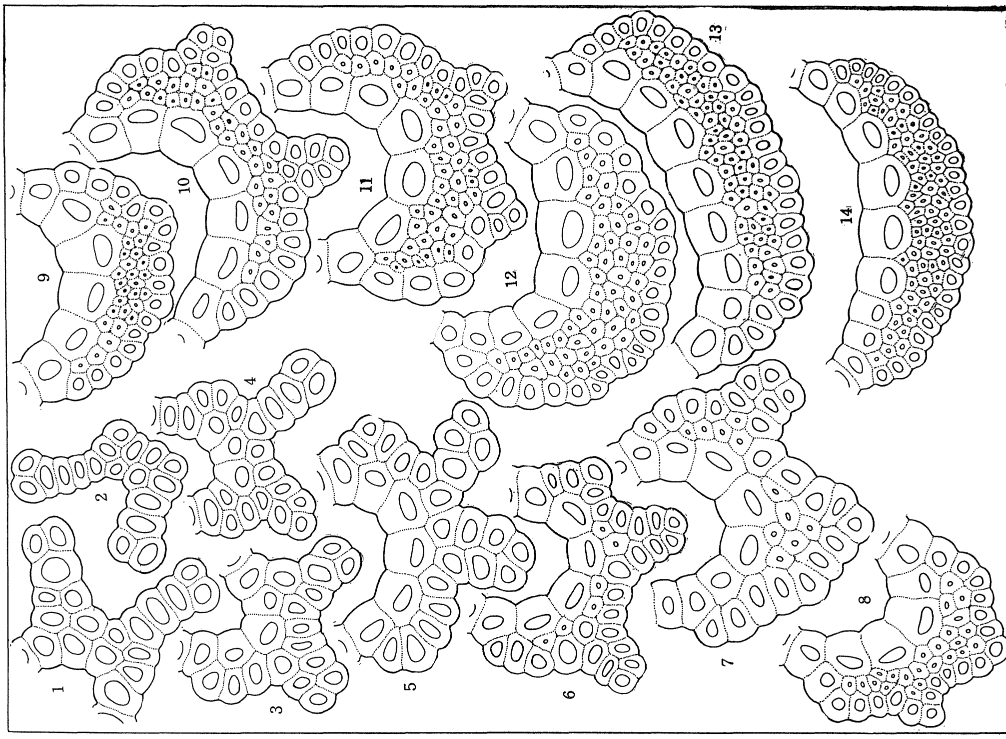
No. 1. *Gr. ovalis* (HEDW.) LINDB.

1. $4a+0b+8c=12$
2. $4a+1b+8c=13$
3. $4a+5b+9c=18$
4. $4a+6b+9c=19$
5. $4a+6b+11c=21$
6. $4a+9b+9c=22$
7. $4a+7b+12c=23$
8. $5a+9b+12c=26$
9. $5a+9b+13c=27$
10. $6a+12b+14c=32$
11. $6a+13b+15c=34$
12. $6a+14b+15c=35$
13. $6a+17b+15c=38$
14. $7a+17b+15c=39$
15. $7a+19b+15c=41$
16. $7a+20b+15c=42$
17. $7a+24b+16c=47$
18. $7a+25b+17c=49$
19. $7a+26b+18c=51$

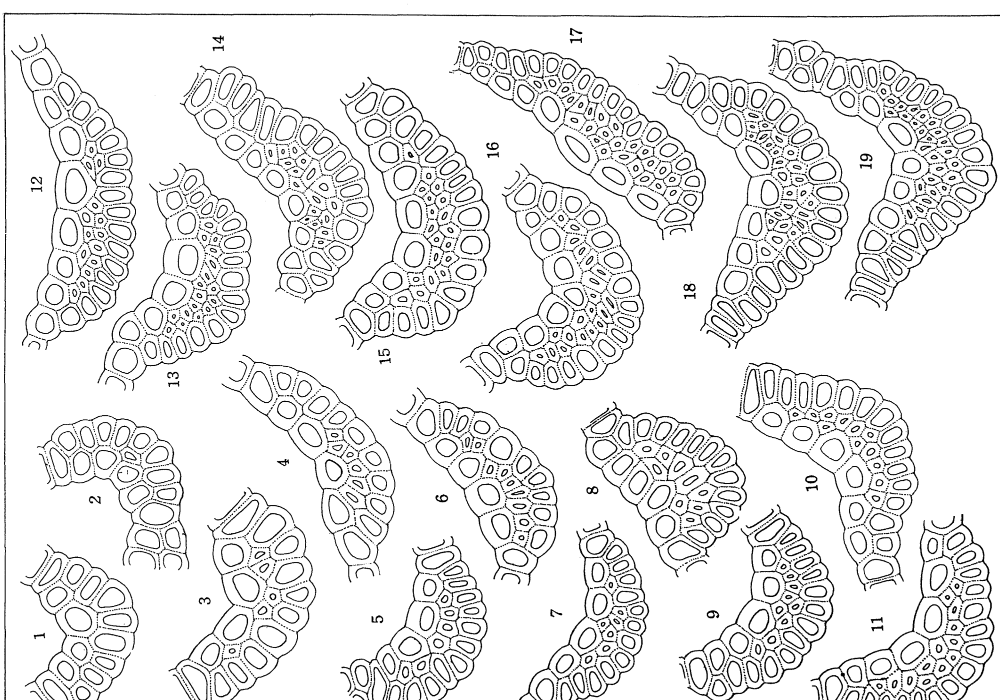
No. 2. *Gr. patens* (HEDW.) B. S. G.

1. $2a+0b+5c=7$
2. $2a+0b+6c=8$
3. $3a+0b+8c=11$
4. $4a+0b+9c=13$
5. $4a+0b+13c=17$
6. $4a+6b+16c=26$
7. $5a+1b+18c=34$
8. $4a+23b+18c=45$
9. $4a+29b+16c=49$
10. $5a+32b+20c=57$
11. $5a+43b+20c=68$
12. $6a+51b+22c=79$
13. $7a+63b+24c=94$
14. $7a+71b+25c=103$

No. 2



No. 1



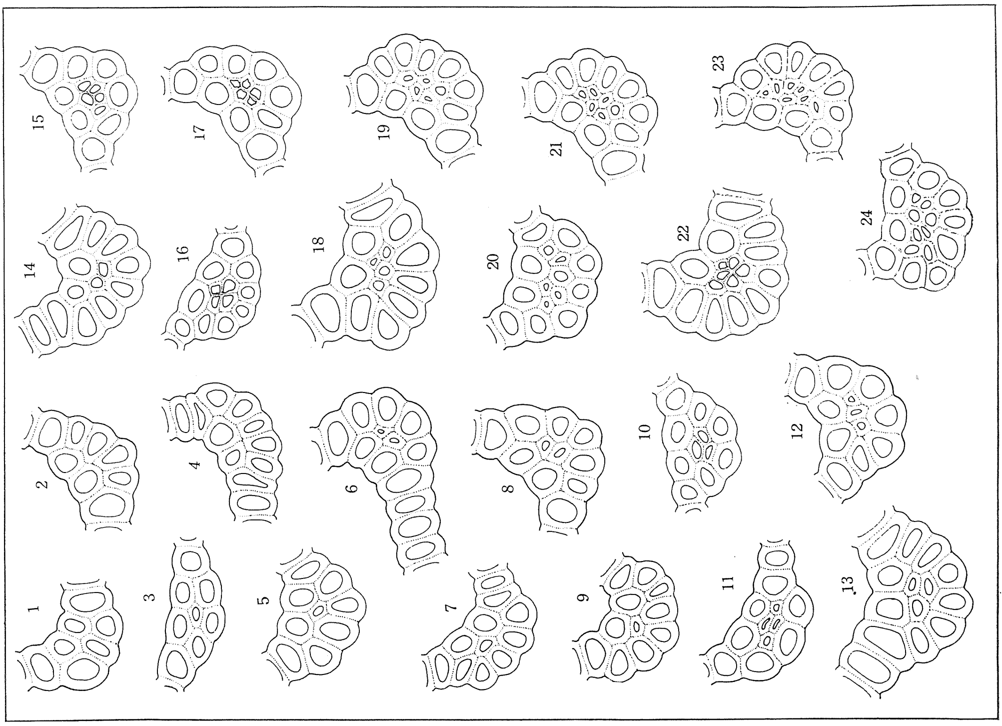
P l a t e XV

No. 1. *Gr. pilifera* P. BEAUV.

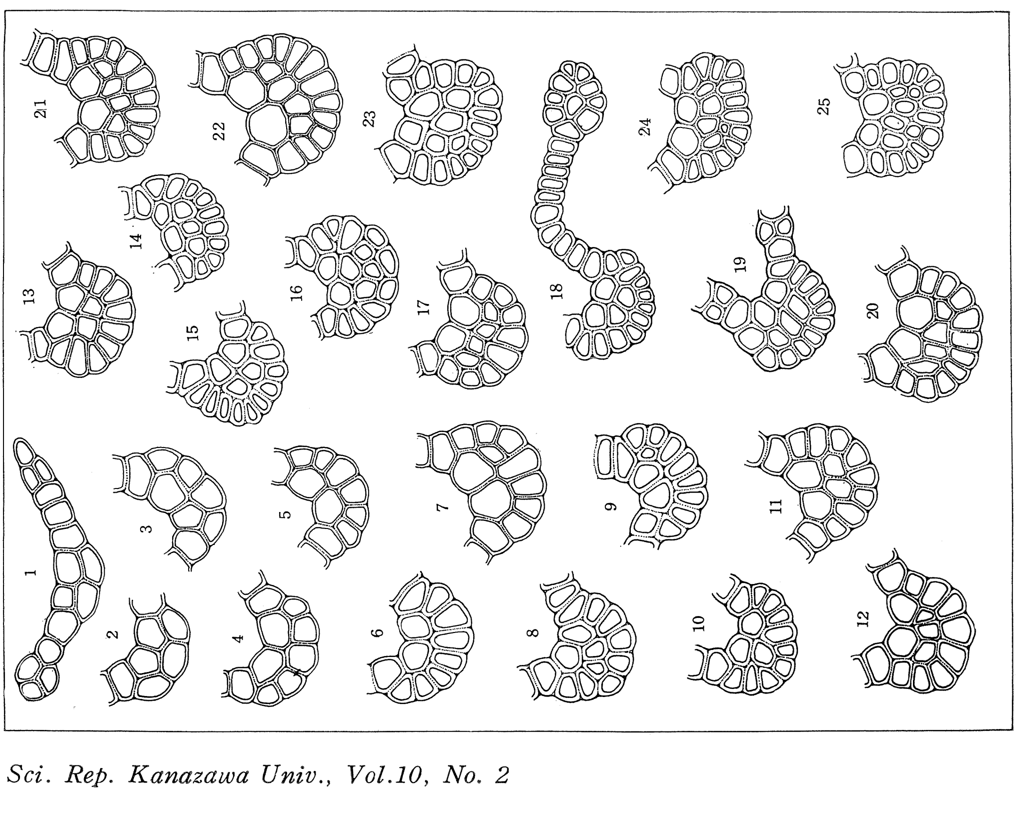
1. $2a+0b+2c=4$
2. $2a+0b+3c=5$
3. $2a+0b+4c=6$
4. $2a+0b+5c=7$
5. $2a+0b+6c=8$
6. $2a+0b+7c=9$
7. $2a+1b+7c=10$
8. $2a+2b+7c=11$
9. $2a+1b+8c=11$
10. $2a+1b+9c=12$
11. $2a+2b+8c=12$
12. $2a+3b+8c=13$
13. $2a+2b+9c=13$
14. $2a+3b+9c=14$
15. $2a+2b+10c=14$
16. $2a+4b+9c=14$
17. $2a+4b+8c=14$
18. $2a+2b+11c=15$
19. $2a+3b+10c=15$
20. $2a+4b+10c=16$
21. $2a+4b+11c=17$
22. $2a+4b+12c=18$
23. $2a+5b+11c=18$
24. $2a+5b+12c=19$
25. $2a+6b+12c=20$

No. 2. *Gr. plagiopodia* HEDW.

1. $2a+0b+3c=5$
2. $2a+0b+4c=6$
3. $2a+1b+3c=6$
4. $2a+0b+5c=7$
5. $2a+1b+4c=7$
6. $2a+2b+4c=8$
7. $2a+1b+5c=8$
8. $2a+2b+5c=9$
9. $2a+1b+6c=9$
10. $2a+3b+4c=9$
11. $2a+4b+3c=9$
12. $2a+3b+5c=10$
13. $2a+3b+6c=11$
14. $2a+2b+6c=10$
15. $2a+5b+4c=11$
16. $2a+4b+5c=11$
17. $2a+5b+5c=12$
18. $2a+4b+6c=12$
19. $2a+5b+6c=13$
20. $2a+6b+5c=13$
21. $2a+6b+6c=14$
22. $2a+6b+7c=15$
23. $2a+7b+6c=15$
24. $2a+8b+6c=16$



No. 2



No .1

Plate XVI

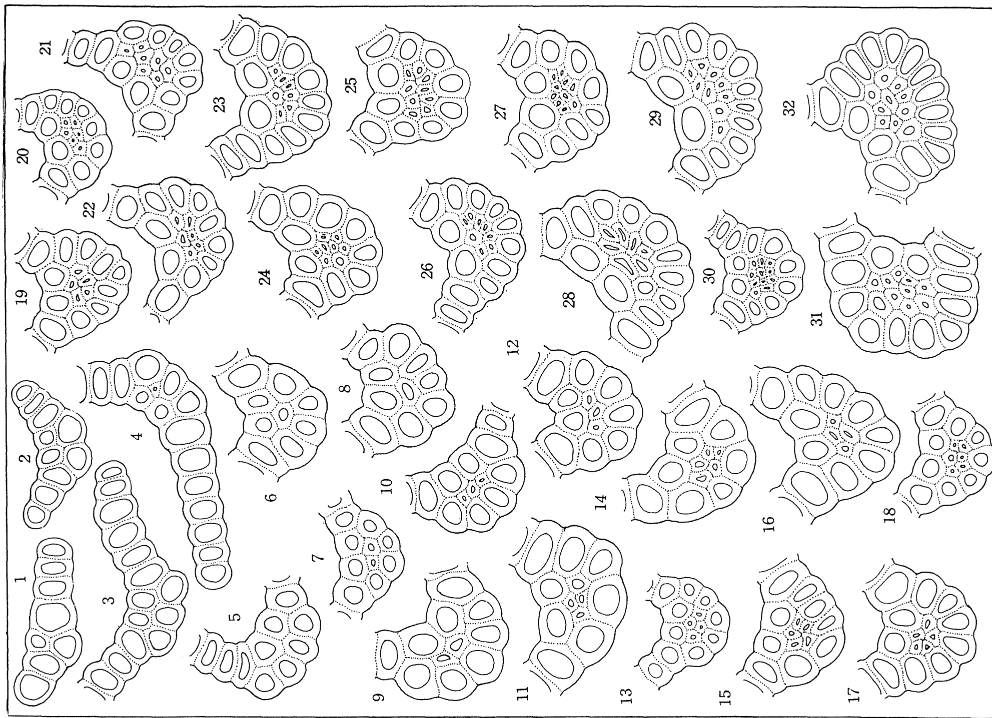
No. 1. *Gr. pulvinata* (HEDW.) SM.

1. 2a+0b+4c=6
2. 2a+0b+5c=7
3. 2a+1b+4c=7
4. 2a+0b+6c=8
5. 2a+2b+4c=8
6. 2a+1b+6c=9
7. 2a+3b+4c=9
8. 2a+1b+7c=10
9. 2a+2b+5c=9
10. 2a+3b+6c=11
11. 2a+4b+4c=10
12. 2a+4b+5c=11
13. 2a+5b+5c=12
14. 2a+4b+6c=12
15. 2a+6b+6c=14
16. 2a+5b+6c=13
17. 2a+5b+7c=14
18. 2a+6b+7c=15

No. 2. *Gr. pulvinata* var. *africana* (HEDW.) HOOK. f. et WILS.

1. 1a+0b+1c=2
2. 2a+0b+2c=4
3. 2a+0b+3c=5
4. 2a+1b+3c=6
5. 2a+0b+4c=6
6. 2a+2b+4c=8
7. 2a+1b+4c=7
8. 2a+2b+5c=9
9. 2a+1b+5c=8
10. 2a+3b+4c=9
11. 2a+4b+4c=10
12. 2a+3b+5c=10
13. 2a+5b+4c=11
14. 2a+4b+5c=11
15. 2a+5b+5c=12
16. 2a+4b+6c=12
17. 2a+5b+6c=13
18. 2a+6b+5c=13
19. 2a+5b+7c=14
20. 2a+6b+6c=14
21. 2a+6b+7c=15
22. 2a+7b+6c=15
23. 2a+8b+6c=16
24. 2a+7b+7c=16
25. 2a+8b+7c=17
26. 2a+9b+6c=17
27. 2a+8b+8c=18
28. 2a+10b+6c=18
29. 2a+11b+6c=19
30. 2a+9b+9c=20
31. 2a+10b+8c=20
32. 2a+10b+11c=23

No. 2



No. 1

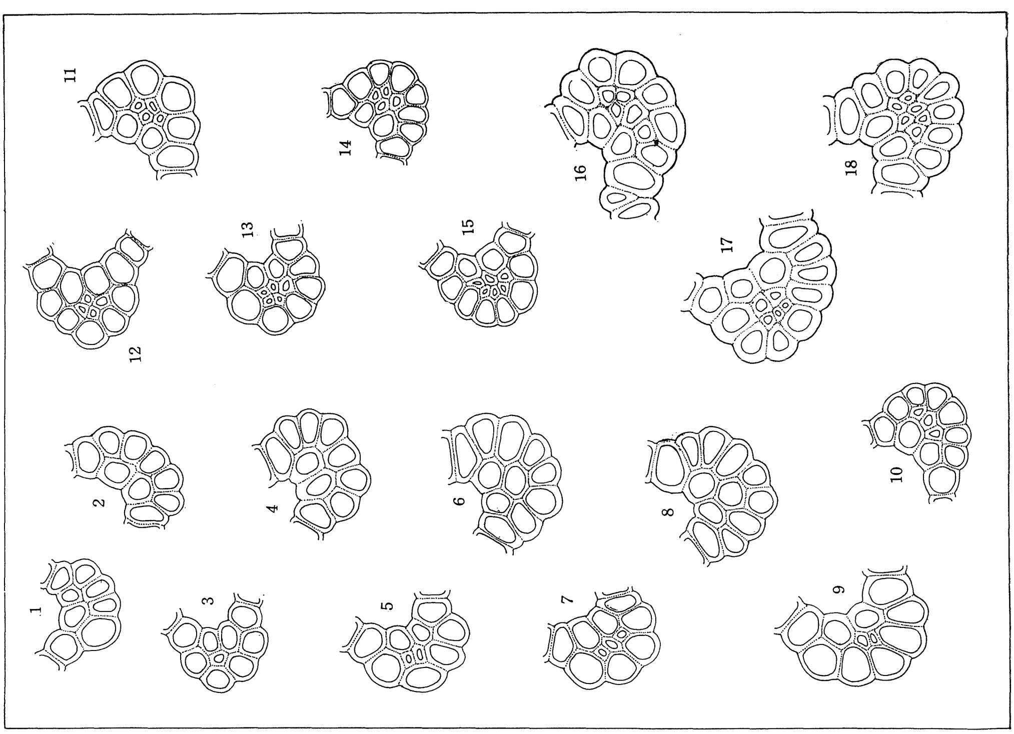


Plate XVII

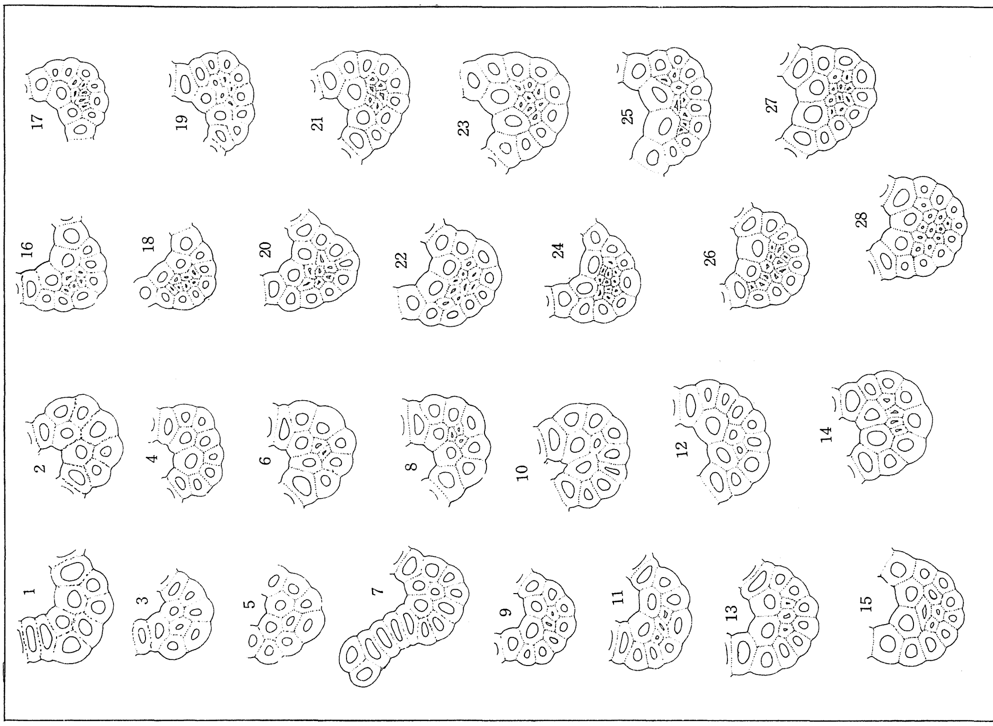
No. 1. *Gr. teretinervis* LIMPR.

1. 2a+0b+4c=6
2. 2a+3b+4c=9
3. 2a+4b+4c=10
4. 2a+5b+4c=11
5. 2a+6b+4c=12
6. 2a+6b+4c=12
7. 2a+5b+5c=12
8. 2a+7b+4c=13
9. 2a+6b+5c=13
10. 2a+7b+5c=14
11. 3a+6b+5c=14
12. 3a+5b+6c=14
13. 3a+6b+6c=15
14. 2a+8b+5c=15
15. 3a+7b+6c=16
16. 2a+8b+6c=16
17. 3a+7b+7c=17
18. 3a+8b+6c=17
19. 4a+7b+7c=18
20. 3a+8b+7c=18
21. 2a+10b+7c=19
22. 4a+8b+7c=19
23. 4a+8b+8c=20
24. 4a+10b+8c=22
25. 4a+11b+8c=23

No. 2. *Gr. trichophylla* ssp. *lisae* (DE NOT.) BOUL.

1. 2a+0b+4c=6
2. 2a+0b+5c=7
3. 2a+1b+4c=7
4. 2a+0b+6c=8
5. 2a+1b+5c=8
6. 2a+2b+5c=9
7. 2a+1b+6c=9
8. 2a+3b+5c=10
9. 2a+2b+6c=10
10. 2a+1b+7c=10
11. 2a+3b+6c=11
12. 2a+2b+7c=11
13. 2a+3b+7c=12
14. 2a+4b+6c=12
15. 2a+4b+7c=13
16. 2a+5b+6c=13
17. 2a+6b+6c=14
18. 2a+7b+6c=15
19. 2a+5b+7c=14
20. 2a+7b+7c=16
21. 2a+6b+7c=15
22. 2a+9b+7c=18
23. 2a+8b+7c=17
24. 2a+11b+6c=19
25. 2a+8b+8c=18
26. 2a+11b+7c=20
27. 2a+10b+7c=19
28. 2a+11b+8c=21

No. 2



No. 1

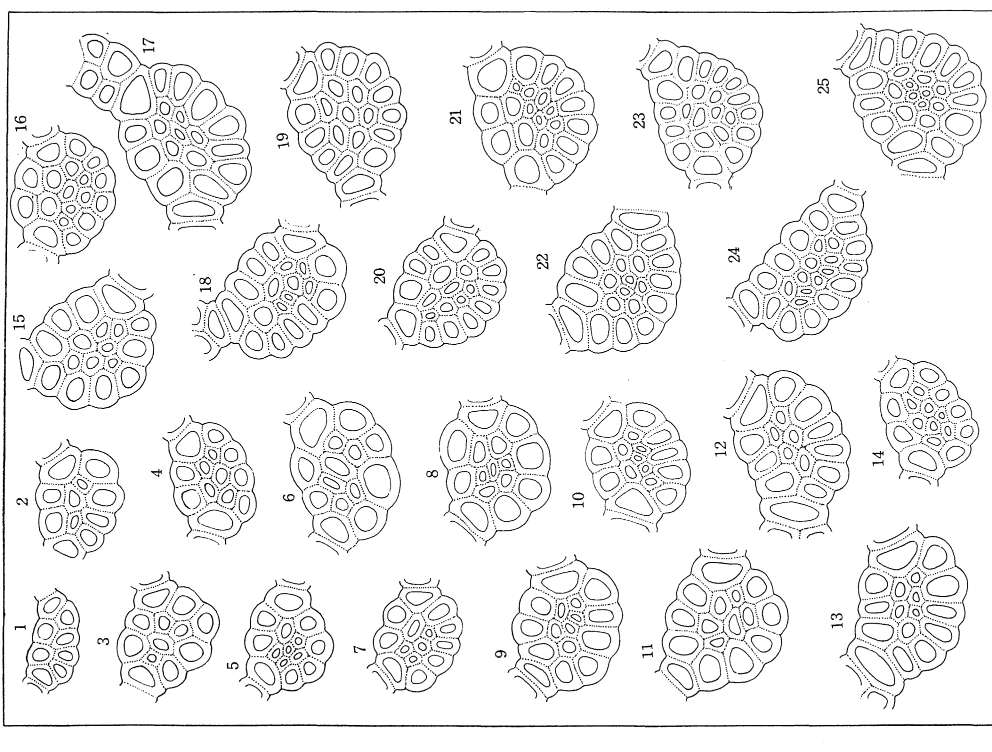


Plate XVIII

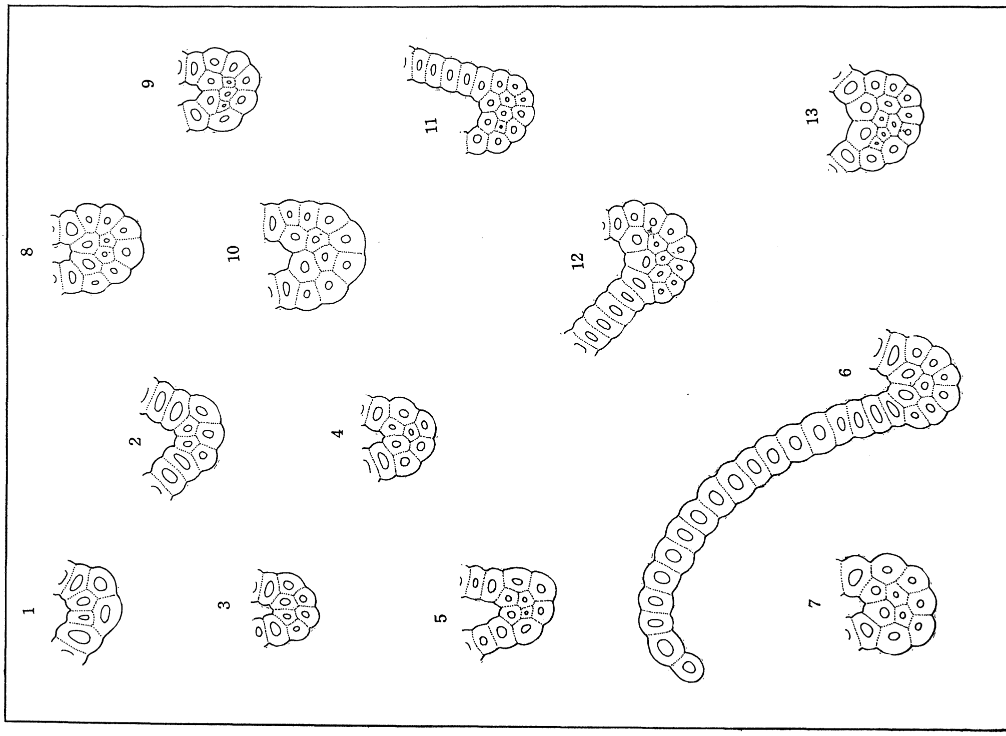
No. 1. *Gr. trichophylla* f. *robusta* PODP.

1. $2a+0b+7c=9$
2. $3a+0b+7c=10$
3. $4a+0b+10c=14$
4. $4a+3b+10c=17$
5. $4a+6b+11c=21$
6. $4a+7b+13c=24$
7. $4a+12b+14c=30$
8. $5a+13b+15c=33$
9. $5a+16b+16c=37$
10. $6a+15b+16c=37$
11. $5a+20b+16c=41$
12. $6a+20b+17c=43$
13. $5a+23b+18c=46$
14. $6a+25b+18c=49$
15. $6a+29b+18c=53$
16. $6a+33b+20c=59$

No. 2. *Gr. torquata* GREV.

1. $2a+0b+2c=4$
2. $2a+0b+3c=5$
3. $2a+0b+4c=6$
4. $2a+1b+4c=7$
5. $2a+2b+4c=8$
6. $2a+1b+6c=9$
7. $2a+2b+5c=9$
8. $2a+2b+6c=10$
9. $2a+3b+5c=10$
10. $2a+2b+7c=11$
11. $2a+3b+6c=11$
12. $2a+3b+7c=12$
13. $2a+5b+7c=14$

No. 2



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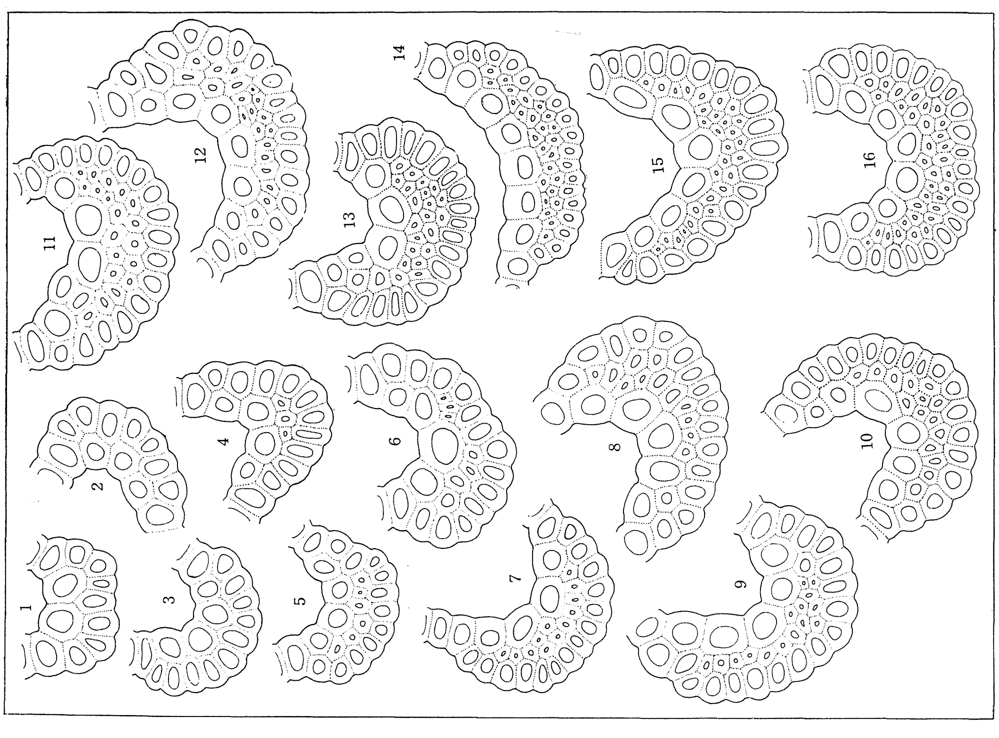


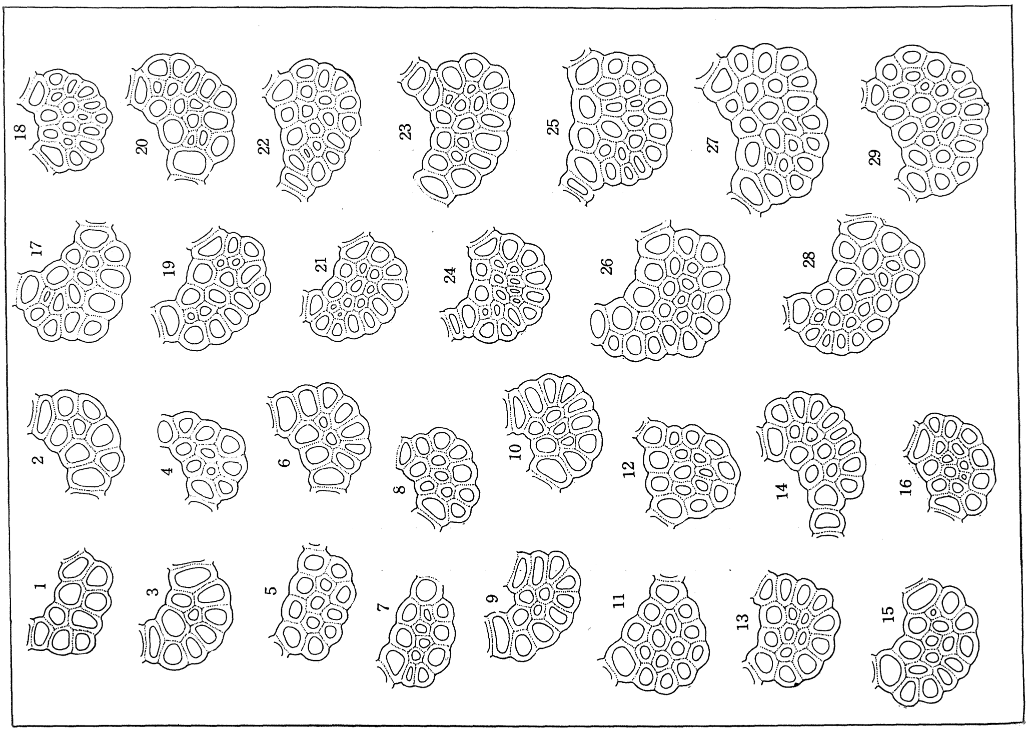
Plate XIX

No. 1. *Gr. brunnescens* f. *epilosa* (SCHIFFN.) PAR.

1. 1a+0b+2c=3
2. 2a+1b+5c=8
3. 2a+2b+6c=10
4. 2a+2b+7c=11
5. 2a+3b+7c=12
6. 2a+2b+8c=12
7. 2a+3b+8c=13
8. 2a+4b+8c=14
9. 2a+5b+7c=14
10. 2a+5b+8c=15
11. 2a+6b+8c=16
12. 2a+6b+9c=17
13. 2a+7b+9c=18
14. 2a+8b+9c=19
15. 2a+7b+10c=19
16. 2a+7b+11c=20
17. 2a+8b+10c=20
18. 2a+9b+9c=20
19. 2a+9b+10c=21
20. 2a+8b+11c=21
21. 2a+9b+11c=22
22. 2a+10b+10c=22
23. 2a+10b+11c=23
24. 3a+9b+11c=23
25. 2a+11b+11c=24
26. 3a+11b+11c=25
27. 2a+13b+11c=26
28. 3a+11b+12c=26
29. 3a+12b+12c=27
30. 3a+12b+13c=28
31. 3a+13b+13c=29

No. 2. *Gr. brunnescens* f. *humilior* VILHL.

1. 2a+0b+5c=7
2. 2a+1b+4c=7
3. 2a+1b+5c=8
4. 2a+2b+5c=9
5. 2a+3b+5c=10
6. 2a+2b+6c=10
7. 2a+4b+5c=11
8. 2a+3b+6c=11
9. 2a+2b+7c=11
10. 2a+3b+7c=12
11. 2a+5b+6c=13
12. 2a+6b+6c=14
13. 2a+5b+7c=14
14. 2a+4b+8c=14
15. 2a+6b+7c=15
16. 2a+7b+6c=15
17. 2a+5b+7c=14
18. 2a+5b+8c=15
19. 2a+6b+8c=16
20. 2a+7b+7c=16
21. 2a+8b+8c=18
22. 2a+7b+8c=17
23. 2a+9b+8c=19
24. 3a+7b+8c=18
25. 3a+10b+8c=21
26. 2a+9b+9c=20
27. 3a+8b+10c=21
28. 3a+9b+9c=21
29. 3a+10b+10c=23



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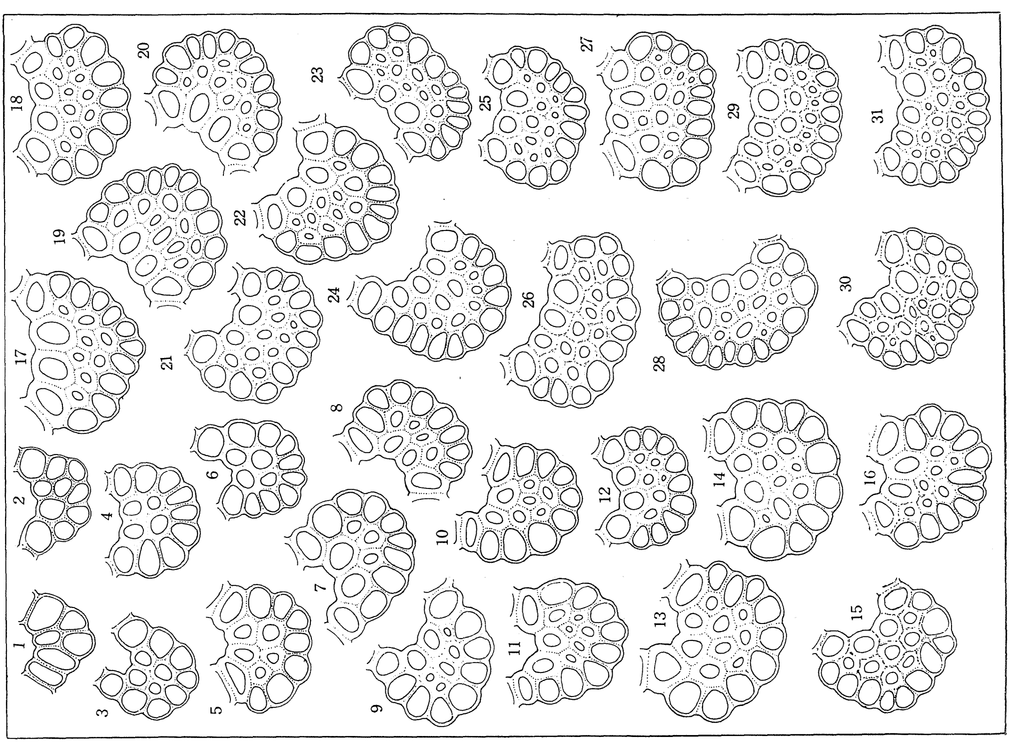


No. 1

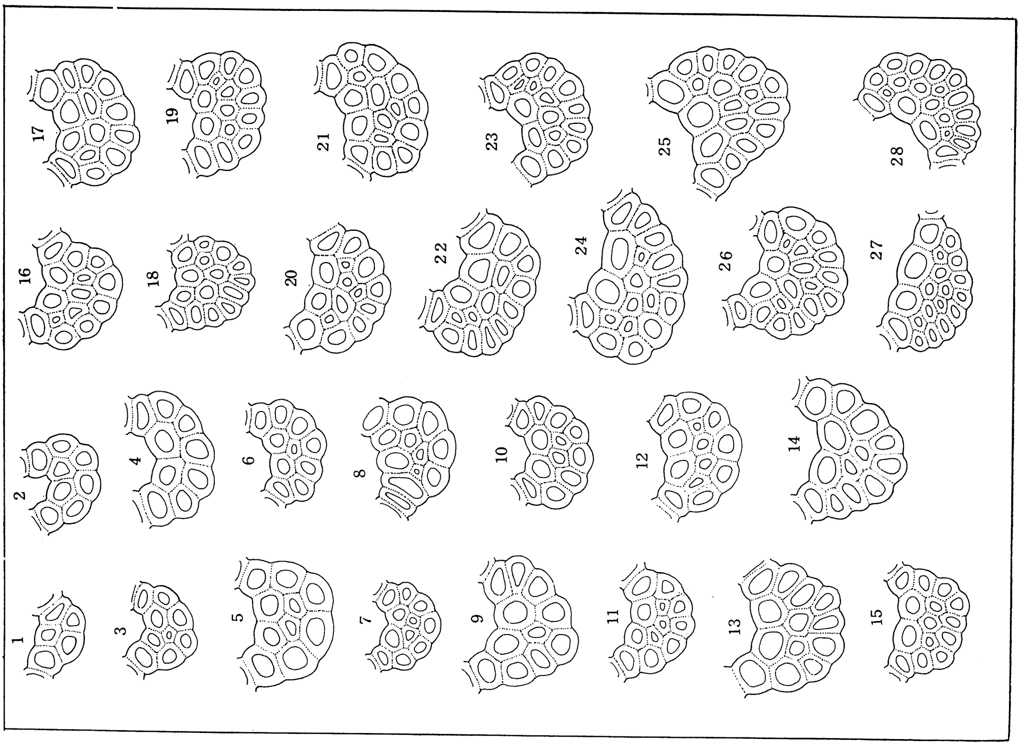
Plate XX

No. 1. *Gr. gracilis* SCHWAEGR.

1. 1a+0b+3c=4
2. 2a+0b+3c=5
3. 2a+0b+4c=6
4. 2a+0b+5c=7
5. 2a+0b+6c=8
6. 2a+1b+5c=8
7. 2a+1b+6c=9
8. 2a+2b+5c=9
9. 2a+2b+6c=10
10. 2a+3b+5c=10
11. 2a+1b+7c=10
12. 2a+3b+6c=11
13. 2a+2b+7c=11
14. 2a+4b+6c=12
15. 2a+3b+7c=12
16. 2a+4b+7c=13
17. 2a+3b+8c=13
18. 2a+4b+8c=14
19. 2a+3b+9c=14
20. 2a+5b+7c=14
21. 2a+5b+8c=15
22. 2a+4b+9c=15

No. 2 *Gr. gracilis* f. *subepilosa* PILOUS.

1. 1a+0b+2c=3
2. 2a+0b+4c=6
3. 2a+1b+4c=7
4. 2a+0b+5c=7
5. 2a+2b+4c=8
6. 2a+1b+5c=8
7. 2a+2b+5c=9
8. 2a+3b+4c=9
9. 2a+1b+6c=9
10. 2a+2b+6c=10
11. 2a+3b+5c=10
12. 2a+4b+5c=11
13. 2a+2b+7c=11
14. 2a+2b+8c=12
15. 2a+3b+6c=11
16. 2a+4b+6c=12
17. 2a+3b+7c=12
18. 2a+3b+8c=13
19. 2a+4b+7c=13
20. 2a+5b+6c=13
21. 2a+5b+7c=14
22. 2a+4b+8c=14
23. 2a+5b+8c=15
24. 2a+6b+8c=16
25. 2a+5b+9c=16
26. 2a+6b+9c=17
27. 2a+7b+8c=17
28. 2a+7b+9c=18



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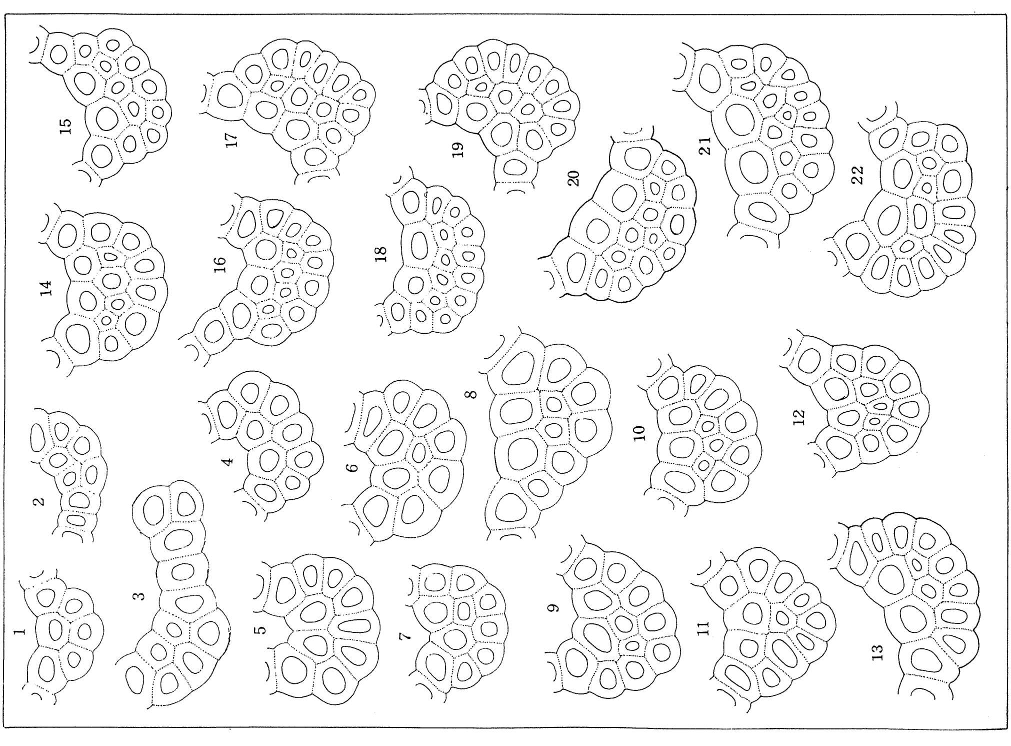

No. 1

P l a t e XXI

Gr. gracilis f. *tenuis* VILHL.

1. $2a+0b+4c=6$
2. $2a+0b+5c=7$
3. $2a+2b+4c=8$
4. $2a+1b+5c=8$
5. $2a+0b+6c=8$
6. $2a+2b+5c=9$
7. $2a+2b+6c=10$
8. $2a+1b+6c=9$
9. $2a+3b+6c=11$
10. $2a+2b+7c=11$
11. $2a+3b+7c=12$
12. $2a+4b+6c=12$
13. $2a+4b+7c=13$
14. $2a+4b+8c=14$
15. $2a+3b+9c=14$
16. $2a+5b+8c=15$
17. $2a+4b+9c=15$
18. $2a+5b+9c=16$
19. $2a+7b+8c=17$
20. $2a+8b+8c=20$
21. $2a+7b+9c=18$
22. $2a+6b+10c=18$
23. $2a+7b+10c=19$
24. $2a+9b+8c=19$
25. $2a+8b+9c=19$
26. $2a+7b+11c=20$
27. $2a+9b+9c=20$
28. $2a+8b+11c=21$
29. $2a+10b+10c=22$
30. $2a+10b+11c=23$
31. $2a+9b+12c=23$
32. $2a+10b+12c=24$
33. $2a+13b+10c=25$
34. $2a+11b+12c=25$
35. $2a+13b+12c=27$

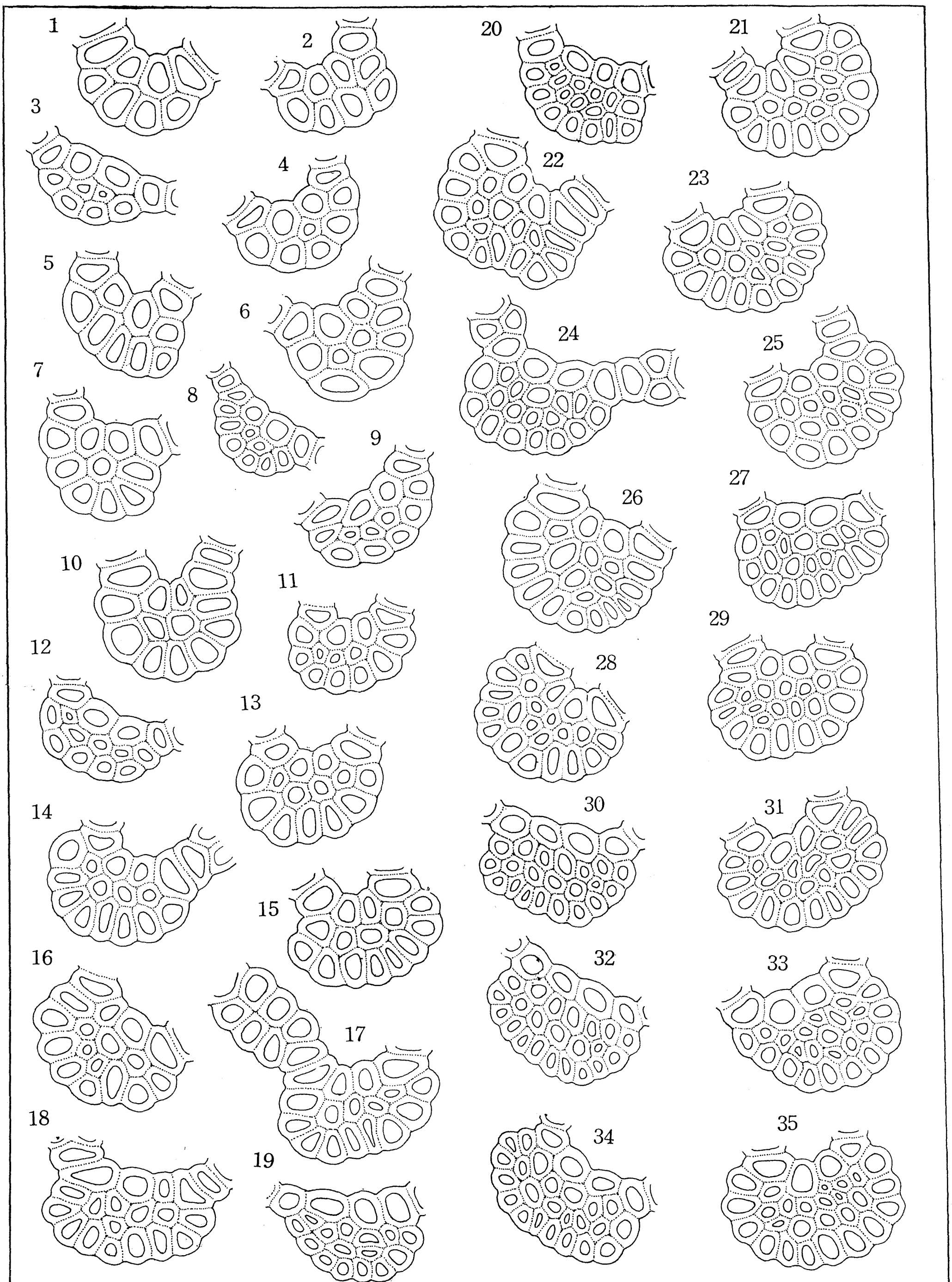
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Plate XXII

Fifteen types in possible combinations of characteristics of leaf cell wall.

A1a : Longitudinal cell wall uniform in thicknees, axis of wall straight; cross cell wall straight, both cell wall same in thickness; length of cross < longtudinal.

A1b : Long. c. w. uniform in thickness, axis of wall straight cross c. w. straight, both cell wall same in thickness; length of cross =long.

A2 : Long c. w. uniform in thickness, axis of wall straight; both cell wall not same in thickness.

A3 : Long. c. w. uniform in thickness, axis of wall waved; cross c. w. straight; length of cross < long.

B1a : Long. c. w. uniform in thickness, axis of wall rippled ; cross c. w. uniform in thickness; length of cross < long. right angle.

B1b : Long. c. w. uniform in thickness, axis of wall rippled ; cross c. w. uniform in thickness; length of cross < long.; oblique angle.

B2a : Long. c. w. uniform in thickness, axis of wall rippled ; cross c. w. uniform in thickness; length of cross > long.; right angle.

B2b : Long. c. w. uniform in thickness, axis of wall rippled; cross c. w. uniform in thickness; length of cross > long.; oblique angle.

B3a : Long. c. w. uniform in thickness, axis of wall rippled; cross c. w. uniform in thickness; length of cross = long.; right angle.

B3b : Long. c. w. uniform in thickness, axis of wall rippled; cross c. w. uniform in thickness; length of cross = long.; oblique angle.

B4 : Long. c. w. uniform in thickness, axis of wall rippled; cross c. w. not uniform in thickness.

C1a : Long. c. w. not uniform in thickness, axis of wall rippled; cross c. w. rippled; length of cross > long.

C1b : Long. c. w. not uniform in thickness, axis of wall rippled; cross c. w. rippled; length of cross = long.

C2 : Long. c. w. not uniform in thickness, axis of wall rippled; cross c. w. straight; length of cross < long.

C3 : Long. c. w. not uniform in thickness, axis of wall straight.

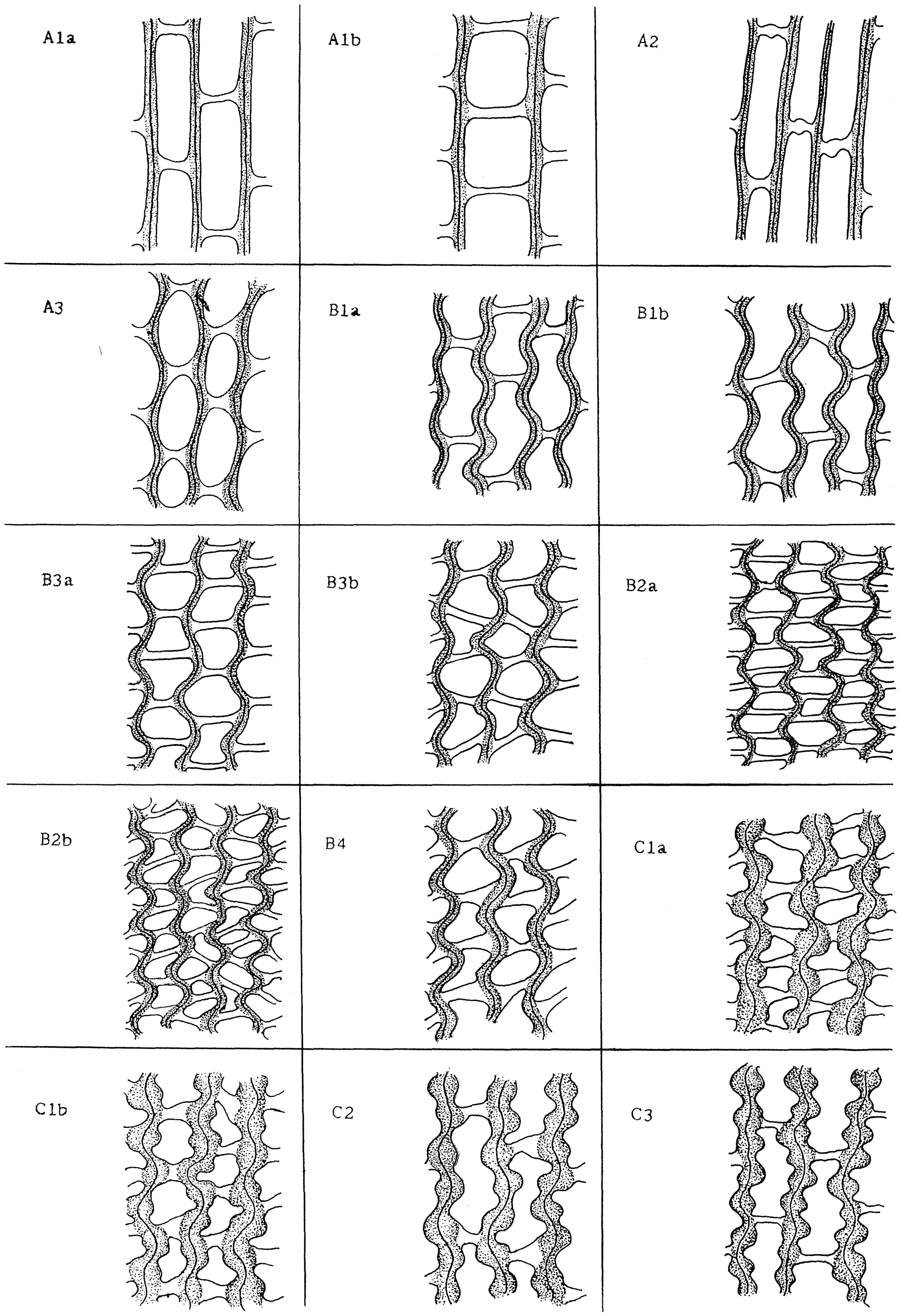
A1a
A1b
A2
A3
B1a
B1b
B3a
B3b
B2a
B2b
B4
C1a
C1b
C2
C3

Plate XXIII

Some types of the laef apex are found in both dry and wet habitats on *Gr. apocarpa.*

1. 2. 6. and 8 : Types of the leaf apex are found in the dry habitat.

3. 4. 5. 7. 9. and 10 : Types of the leaf apex are found in the wet habitat.

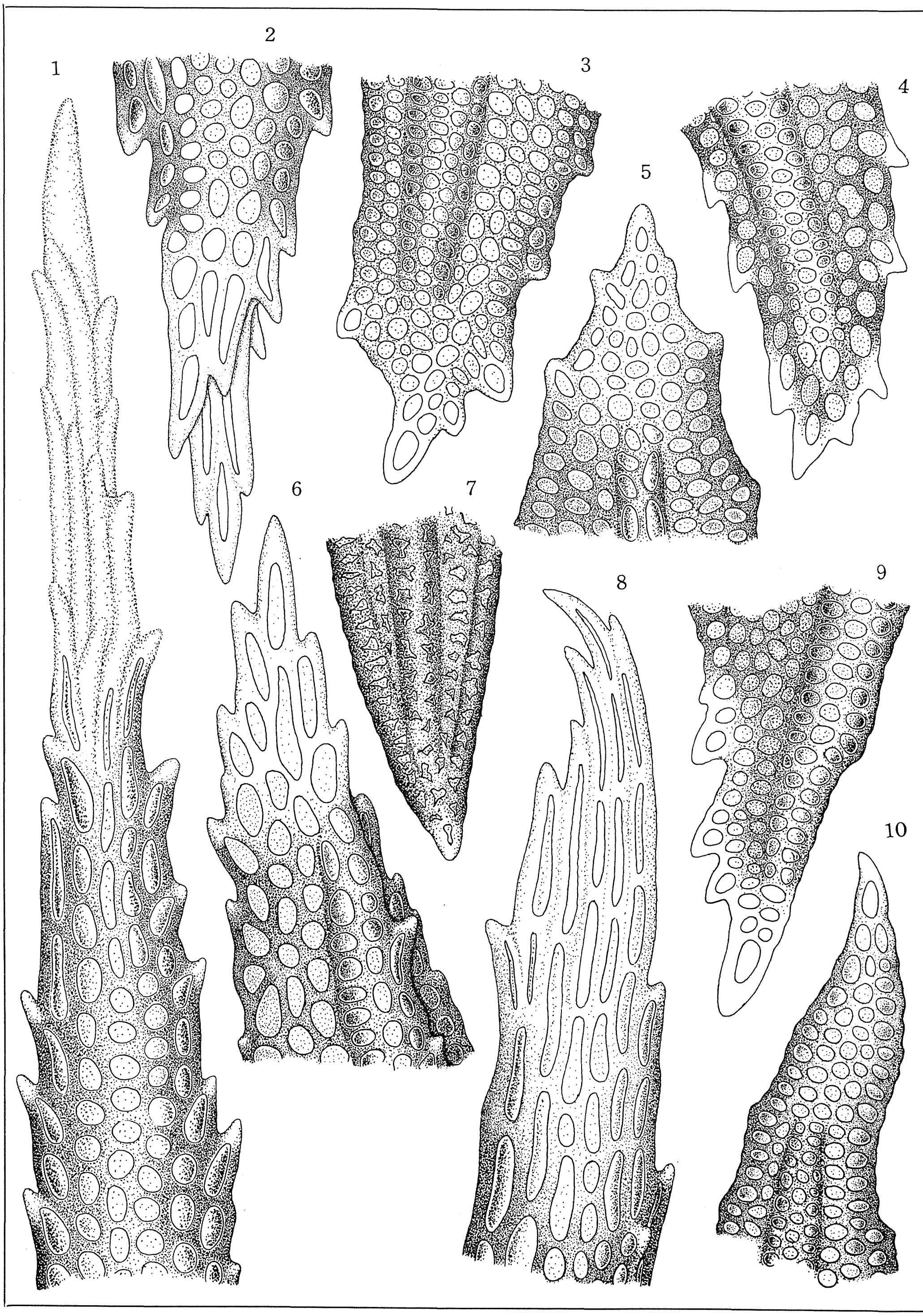
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Plate XXIV

Gr. agassizii (SULL. et LESQ.) JAEG.

1. cross section of midrib $\times 450$
2. cross section of leaf margin $\times 450$
3. leaf $\times 36$
4. leaf apex $\times 300$
5. cross section of stem $\times 300$
6. midrib cells of median leaf $\times 300$
7. margin cells of median leaf $\times 300$
8. plant habit $\times 3$
9. margin cells of leaf base $\times 300$
10. midrib cells of leaf base $\times 300$

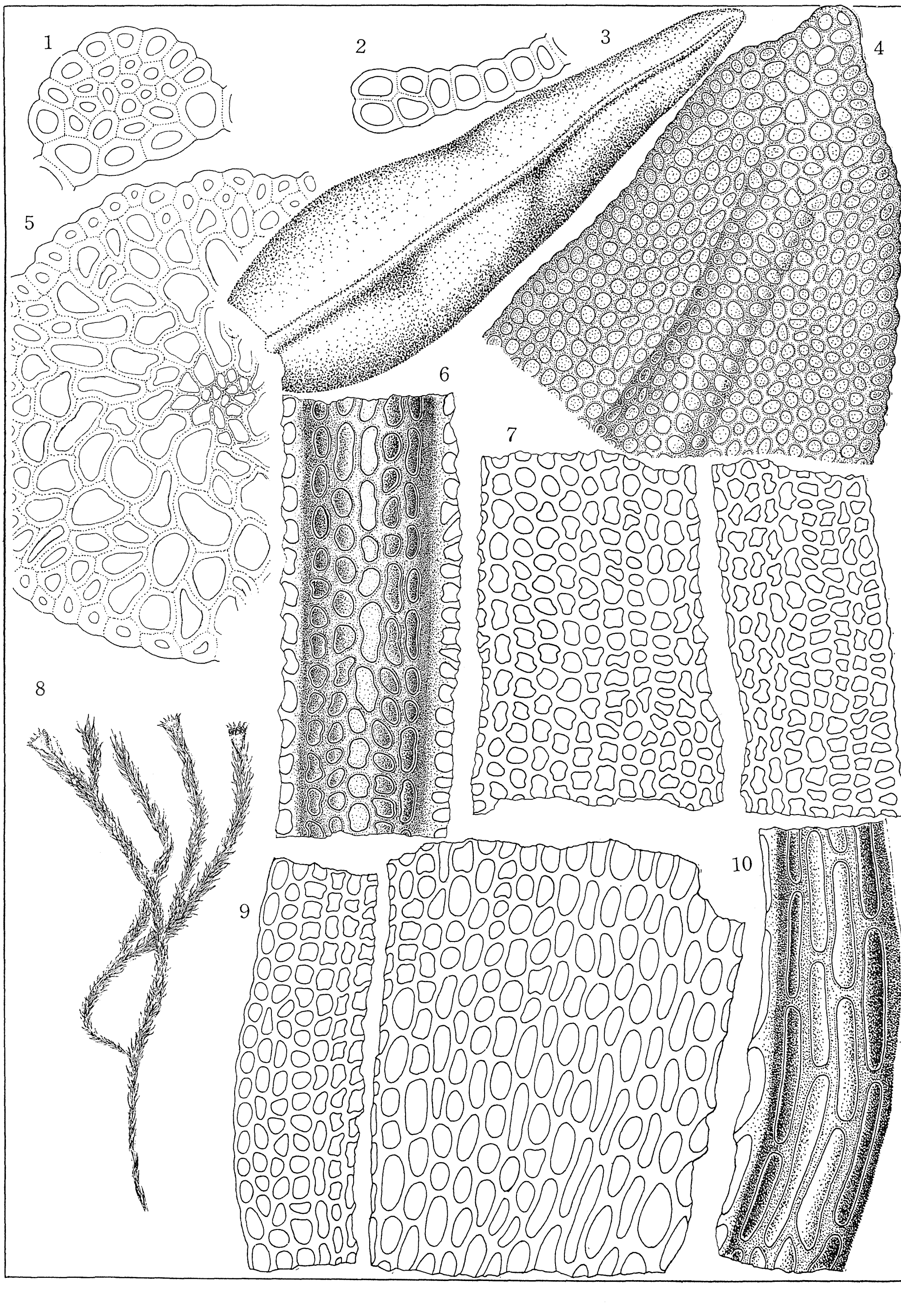
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Plate XXV

Gr. alpicola HEDW.

1. plant habit $\times 5$
2. leaf $\times 18$
3. female plant $\times 15$
4. leaf apex $\times 150$
5. median leaf cells $\times 300$
6. leaf base cells $\times 300$
7. cross section of midrib $\times 450$
8. cross section of leaf margin $\times 450$
9. cross section of stem $\times 300$

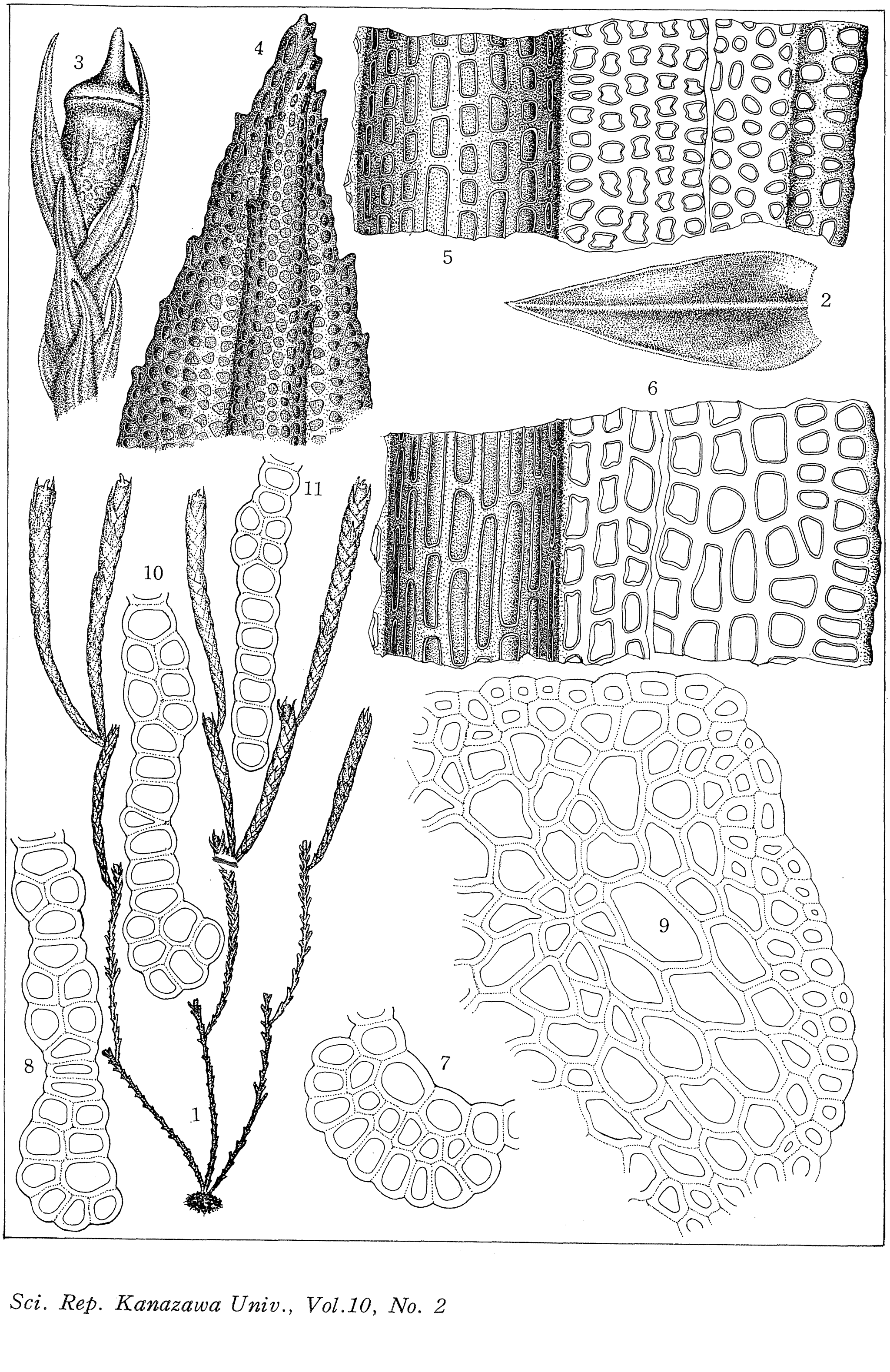
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Plate XXVI

Gr. anodon B. S. G.

1. 2. and 4. leaf apexes $\times 300$
3. leaf $\times 36$
5. cross section of stem $\times 300$
6. median leaf cells $\times 300$
7. leaf base cells $\times 300$
8. cross section of midrib $\times 450$
9. and 10. cross sections of leaf margin $\times 450$

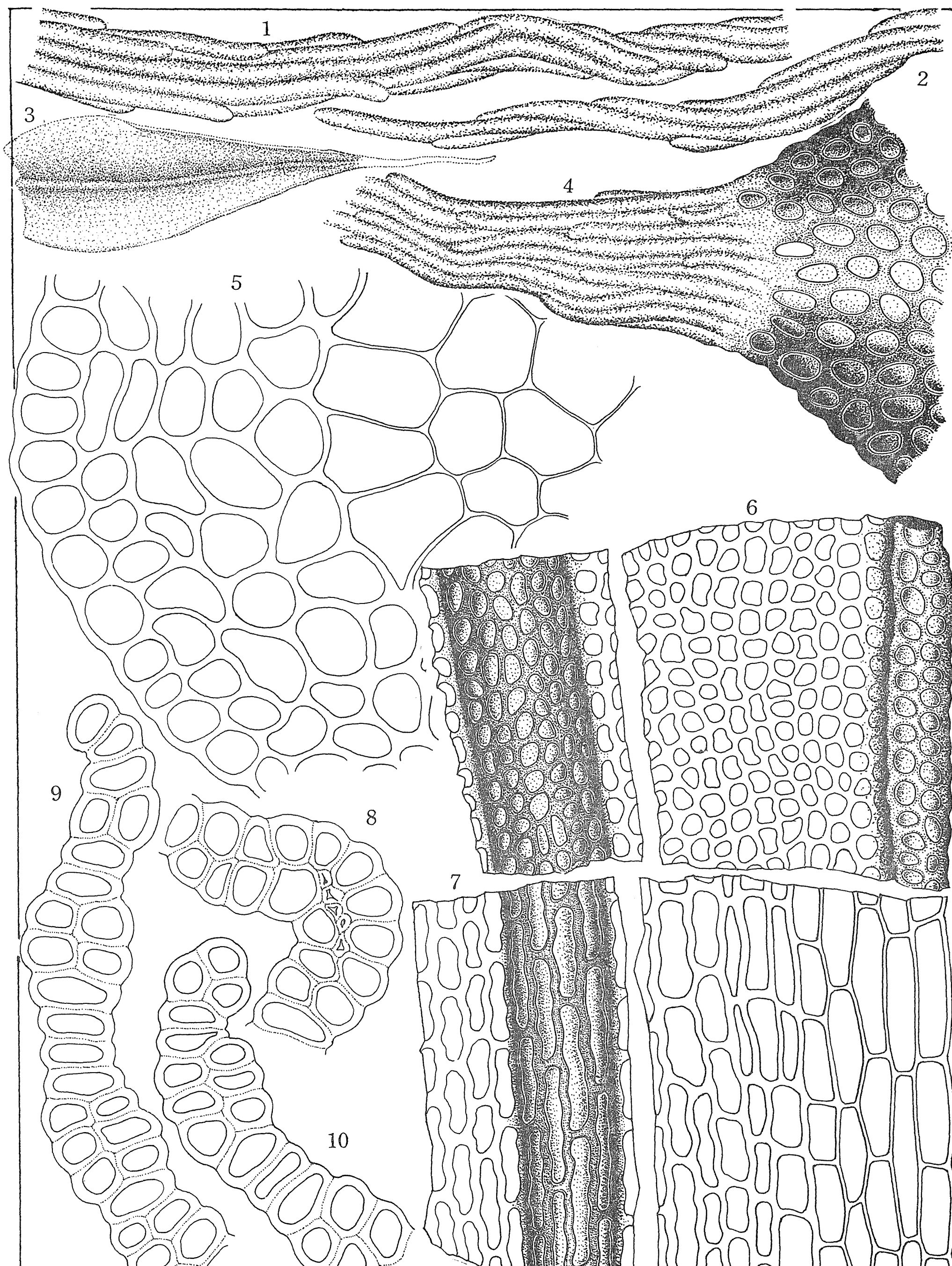
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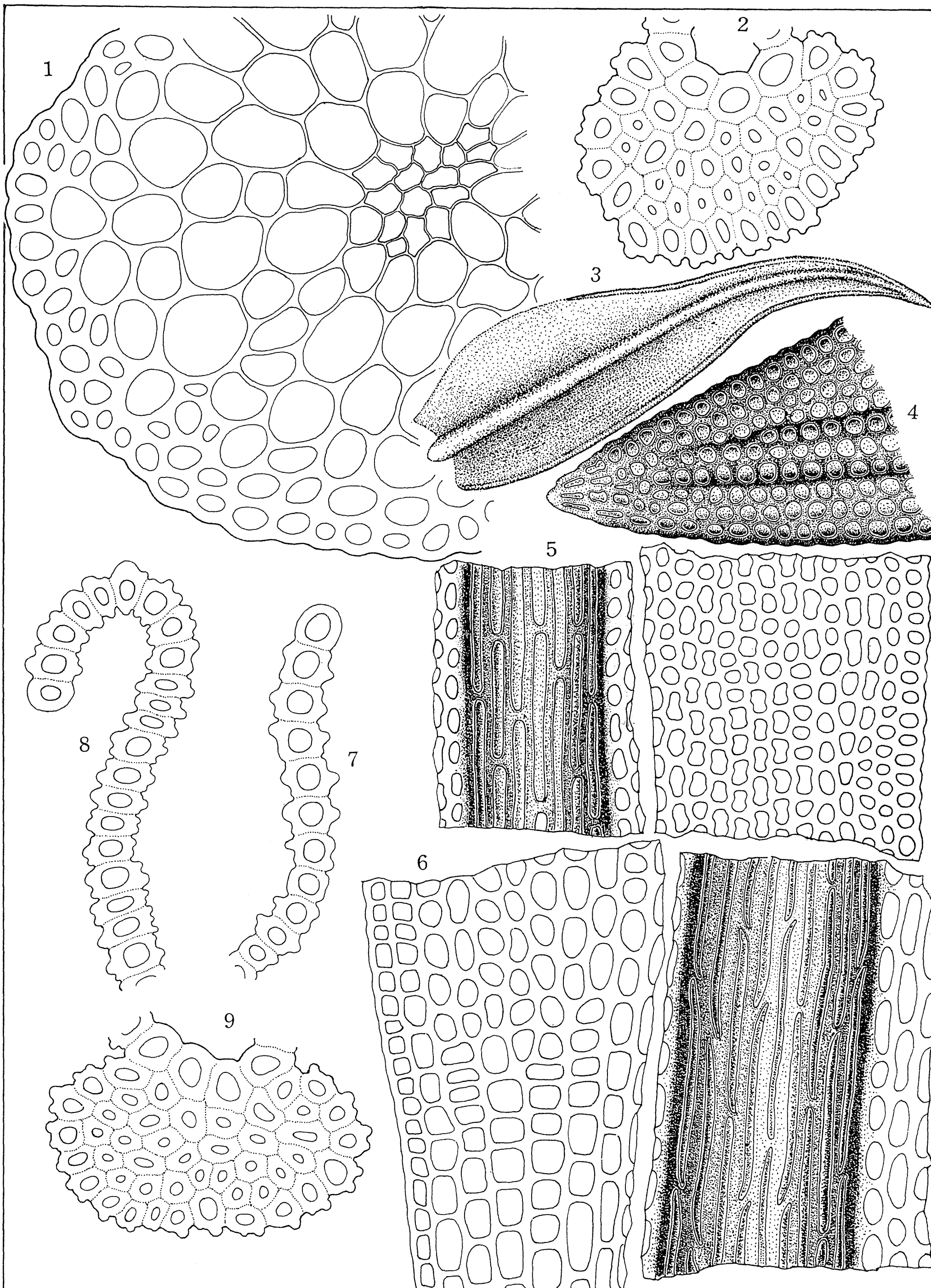
Plate XXVII

Gr. anomala HAMPE

1. cross section of stem ×300
2. cross section of midrib ×450
3. leaf ×36
4. leaf apex ×300
5. median leaf cells ×300
6. leaf base cells ×300
7. and 8. cross sections of leaf margin ×450
9. cross section of midrib ×450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P l a t e XXVIII

Gr. apocarpa HEDW.

1. plant habit ×10
2. leaf ×36
3. female plant with capsule ×15
4. leaf apex ×300
5. median leaf cells ×300
6. leaf base cells ×300
7. cross section of midrib ×450
8. cross section of leaf margin ×450
9. cross section of stem ×300
10. peristome teeth ×150

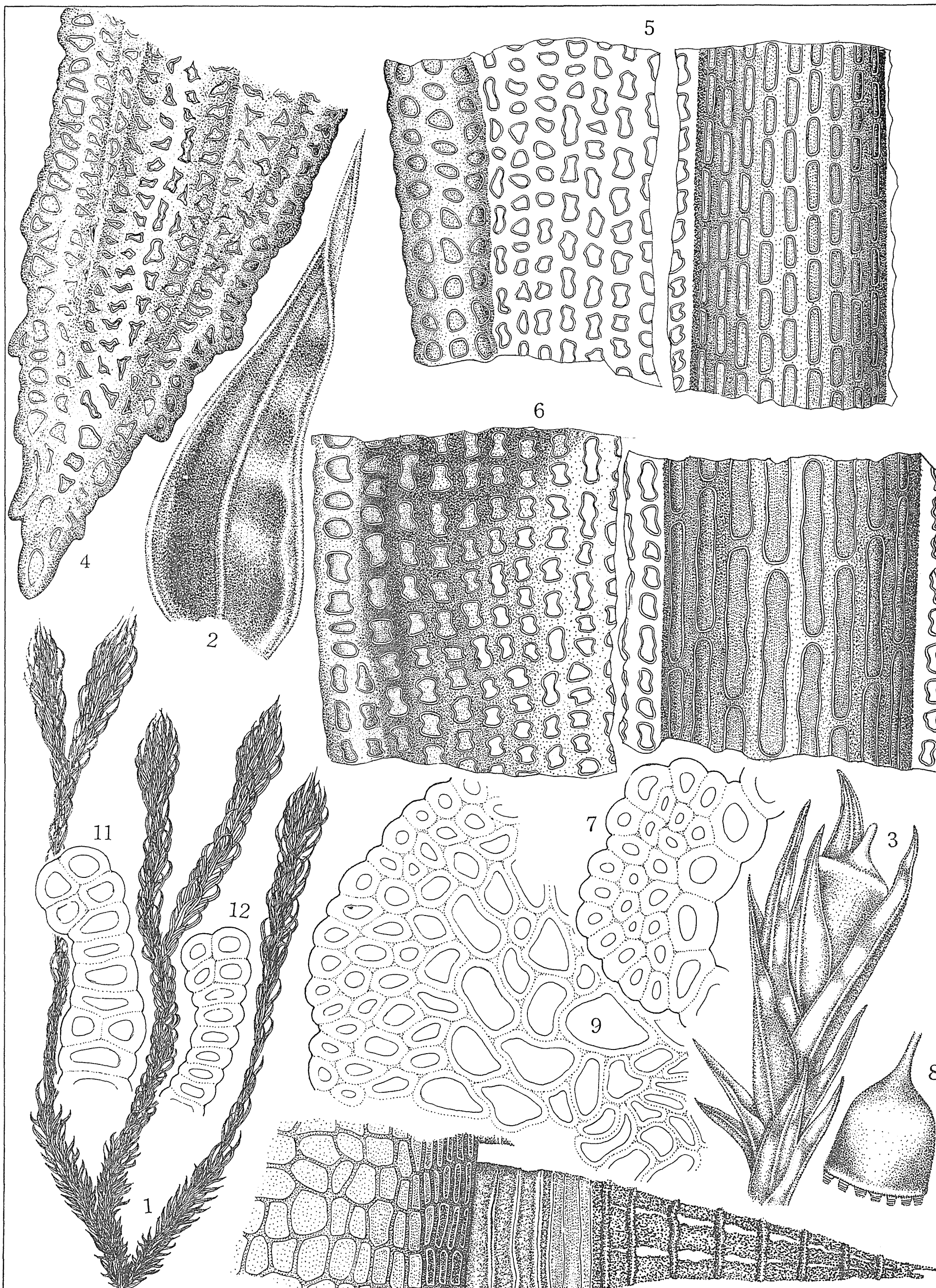
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Plate XXIX

Gr. apocarpa var. *atrofusca* (SCHIMP.) HUSN.

1. cross section of stem ×300
2. and 3. cross sections of leaf margin ×450
4. leaf apex ×300
5. plant habit ×7.5
6. cross section of midrib ×450
7. median leaf cells ×300
8. leaf base cells ×300
9. leaf ×36

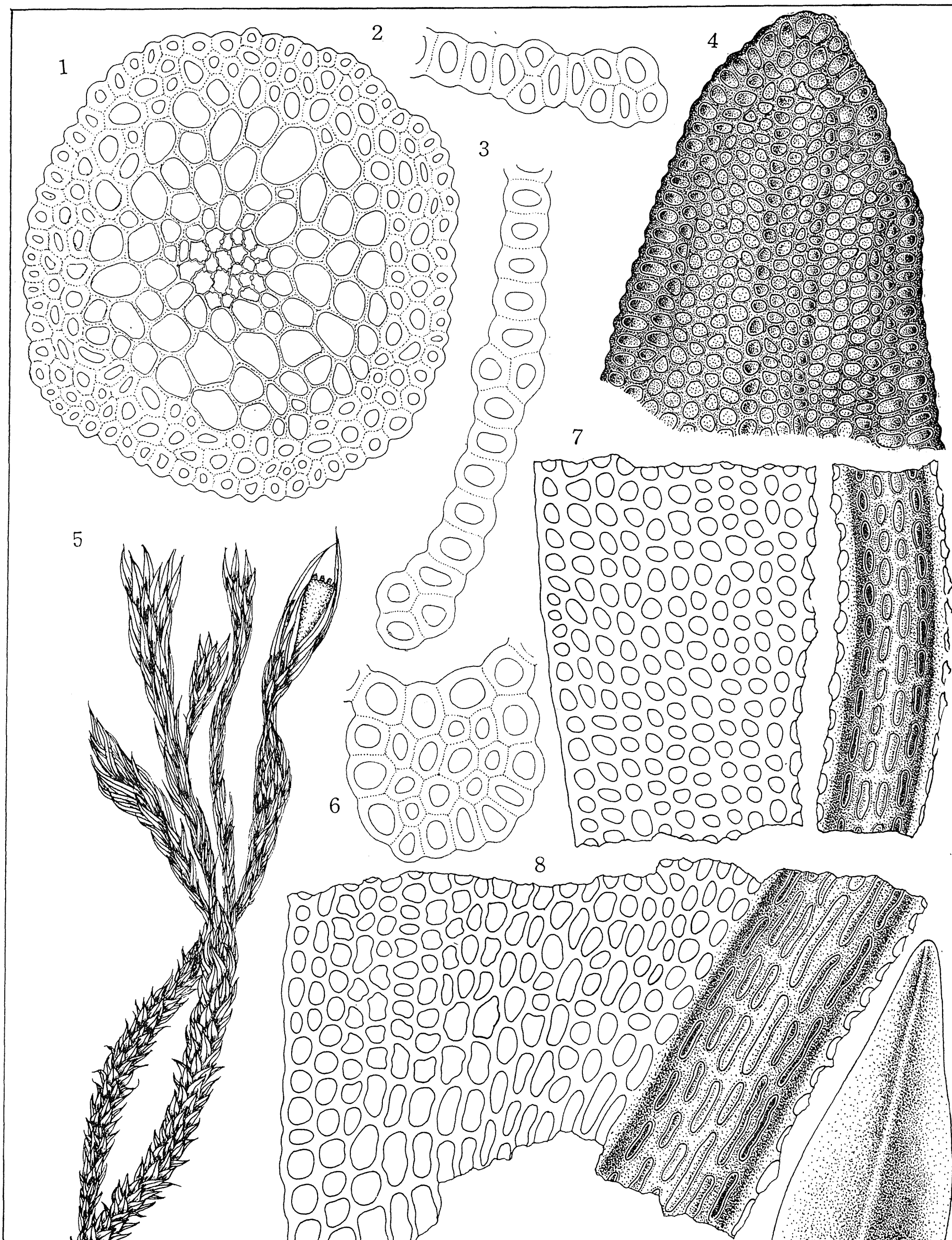
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Plate XXX

Gr. apocarpa var. *conferta* (Funck) Spreng.

1. and 2. cross sections of leaf margin $\times 450$
3. median leaf cells $\times 300$
4. and 5. leaf apex $\times 300$
6. cross section of midrib $\times 450$
7. cross section of stem $\times 300$
8. leaf $\times 36$
9. plant habit $\times 7.4$
10. leaf base cells $\times 300$

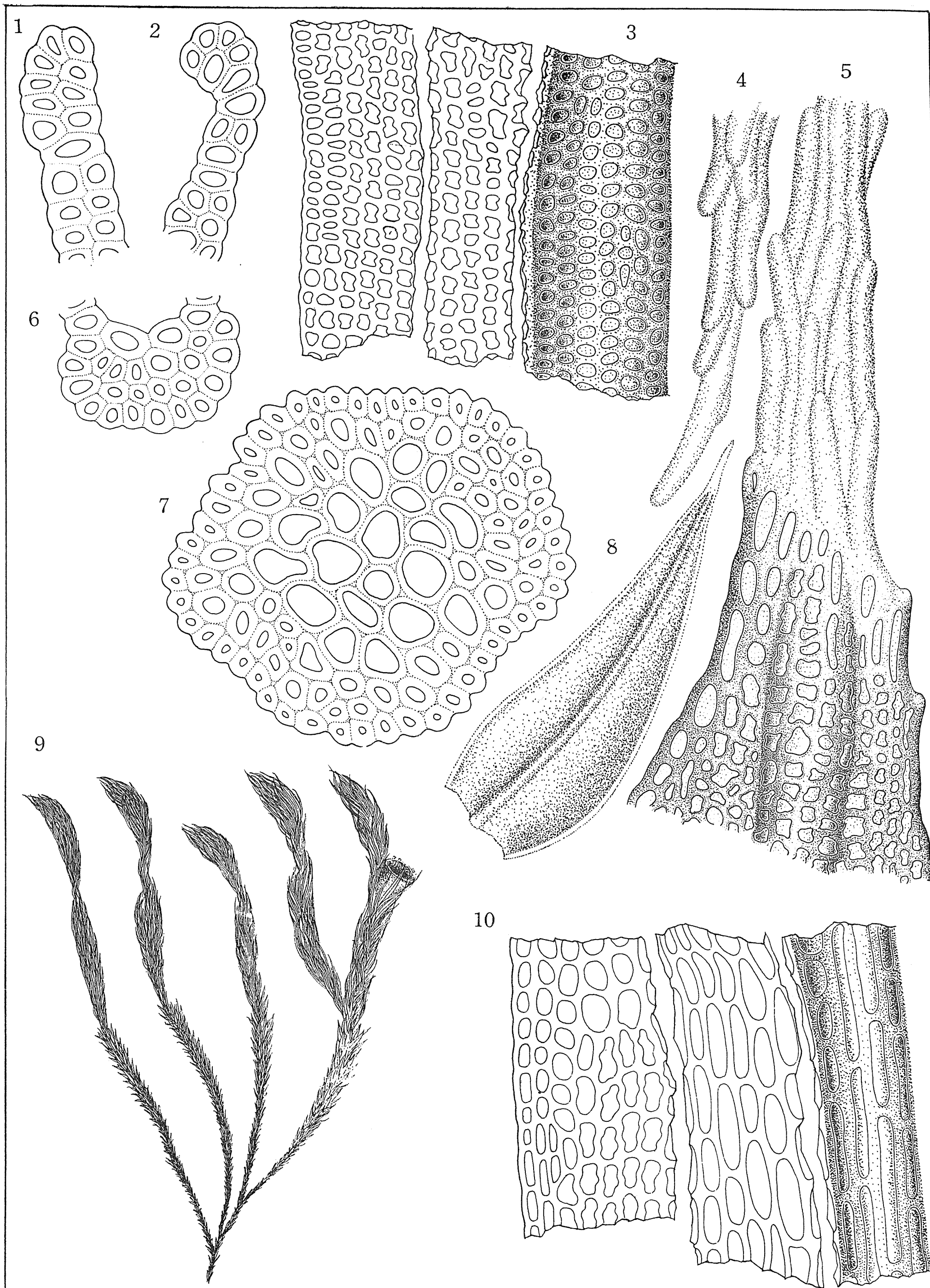
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Plate XXXI

Gr. apocarpa var. *microtheca* CARD.

1. plant habit ×7
2. leaf ×18
3. female plant with capsule ×15
4. leaf apex ×150
5. median leaf cells ×300
6. leaf base cells ×300
7. cross section of midrib ×450
8. cross section of leaf margin ×450
9. cross section of stem ×300

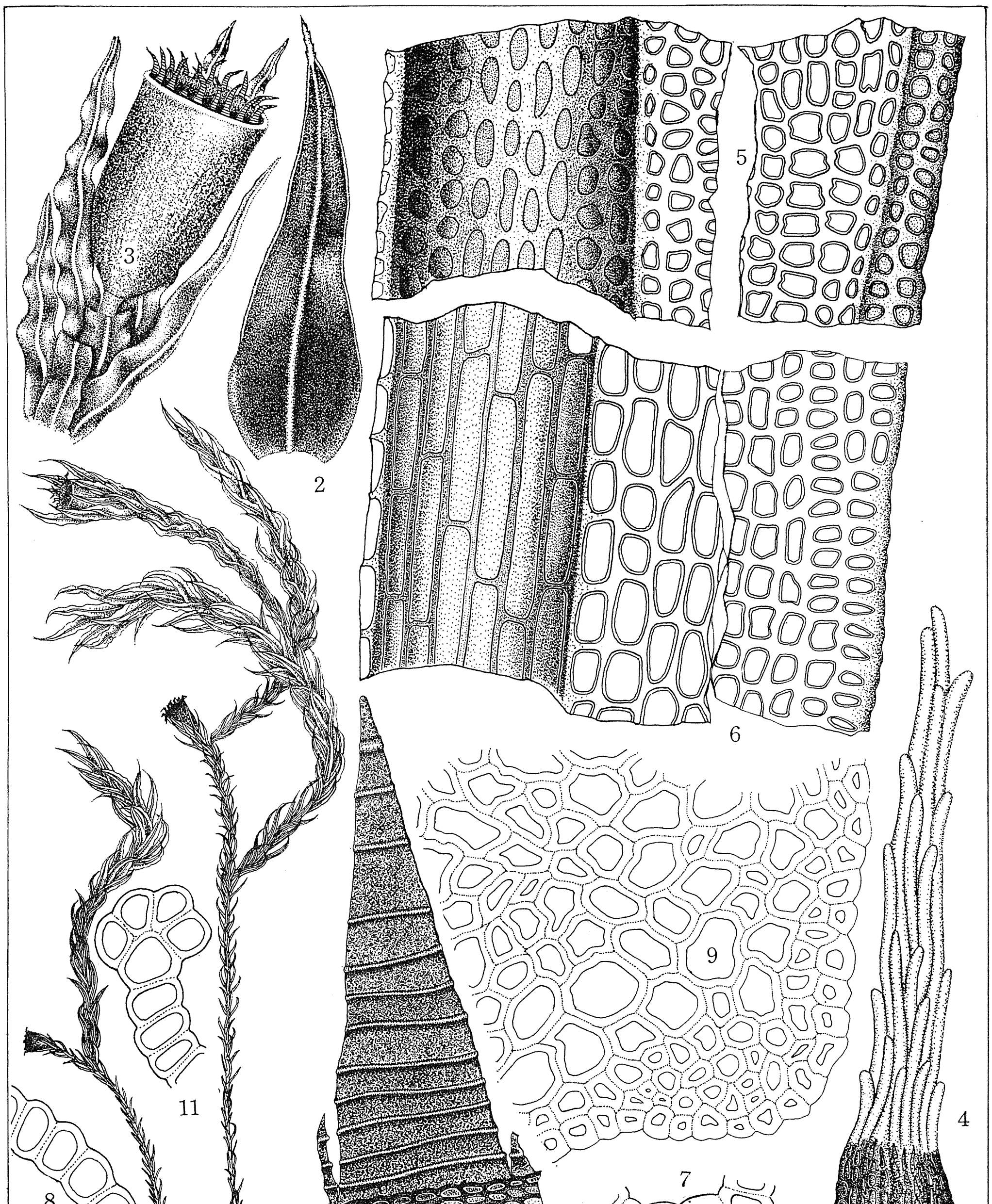
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Plate XXXII

Gr. apocarpa var. *rivularis* (BRID.) NEES et HORNSCH.

1. plant habit ×7
2. leaf ×36
3. female plant ×15
4. leaf apex ×150
5. median leaf cells ×300
6. leaf base cells ×300
7. cross section of midrib ×450
8. cross section of leaf margin ×450
9. cross section of stem ×300

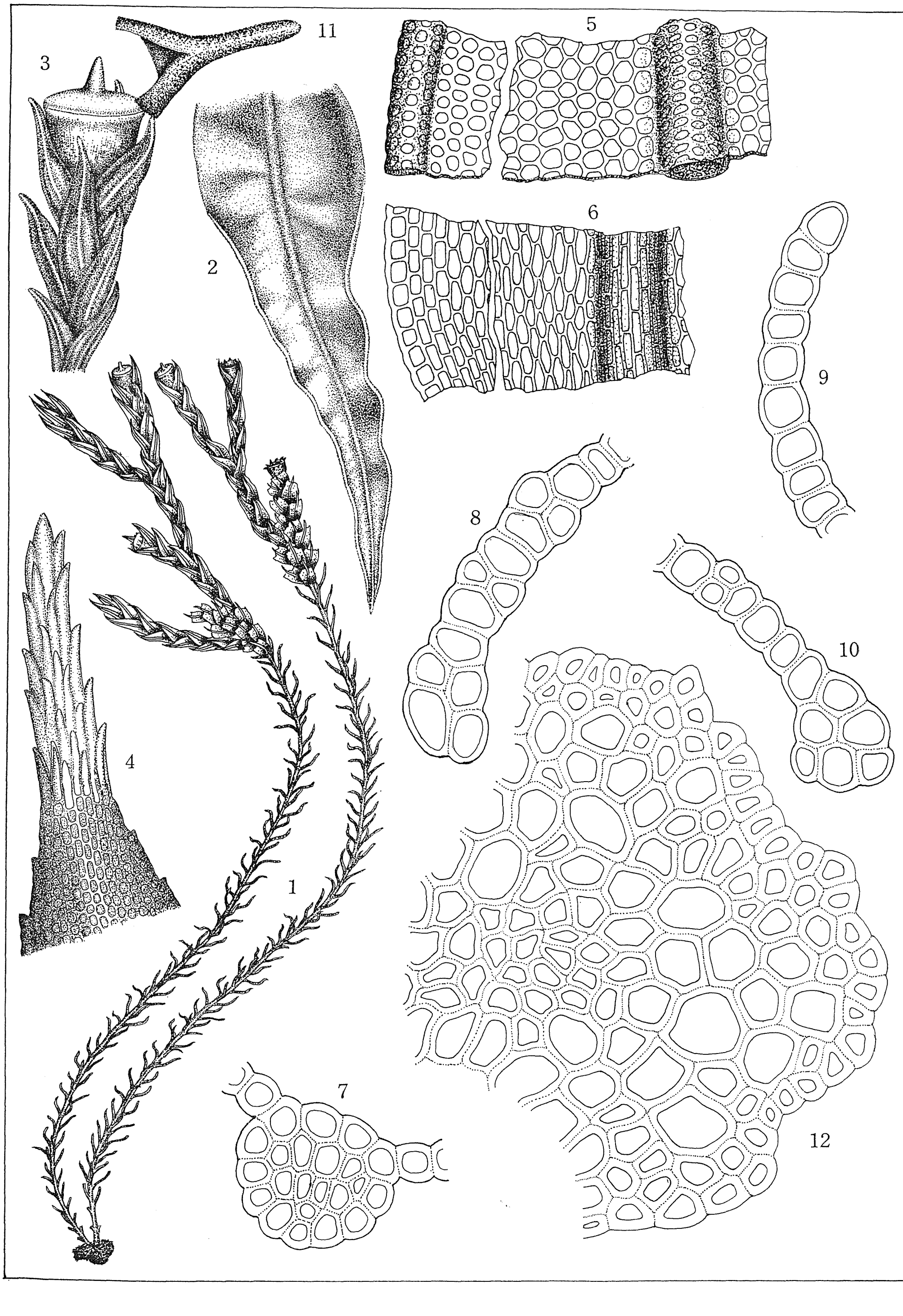
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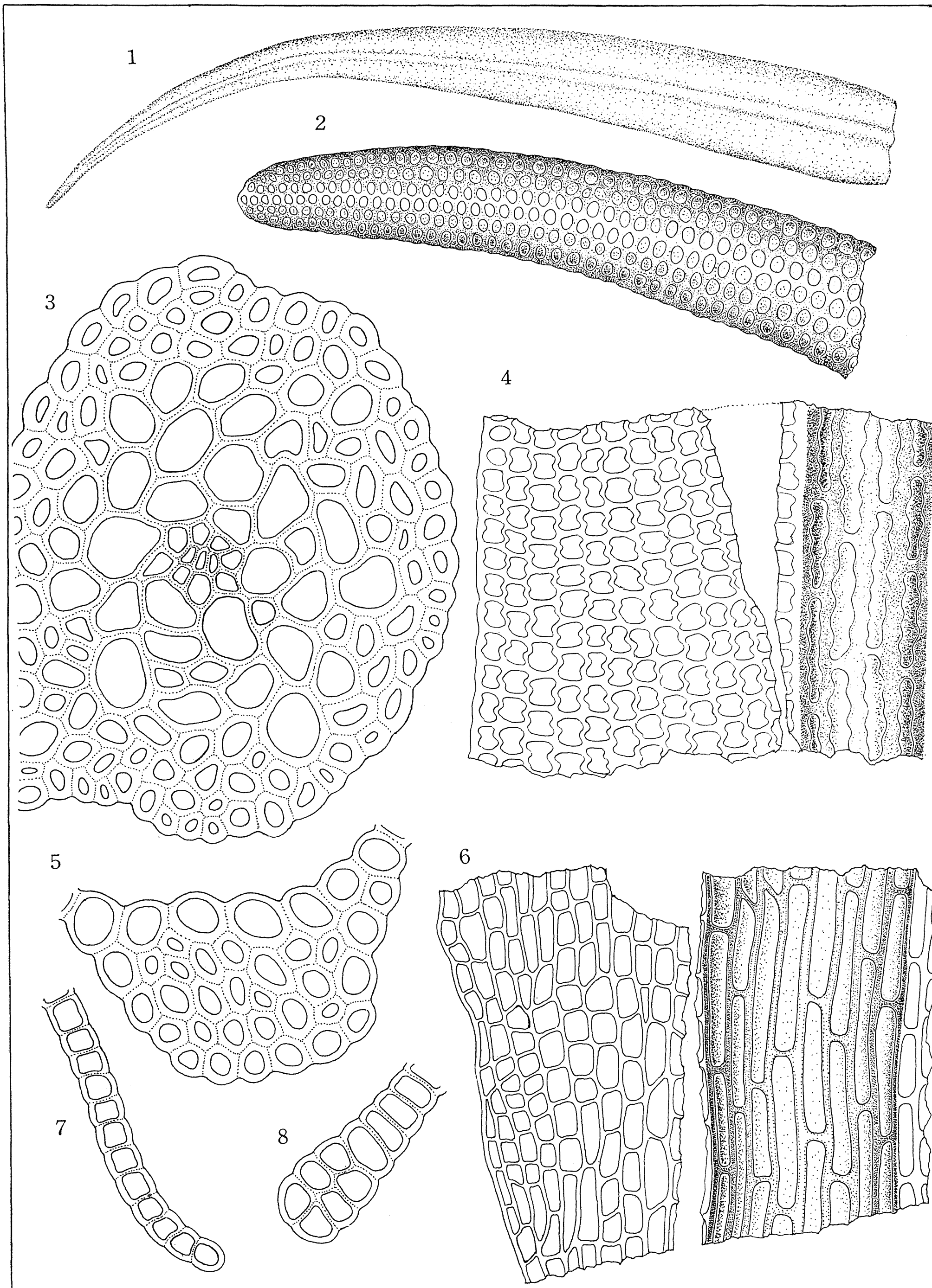
Plate XXXIII

Gr. apocarpa var. *rivularis* f. *acutifolia* (T. JENS.)

1. leaf ×36
2. leaf apex ×300
3. cross section of stem ×300
4. median leaf cells ×300
5. cross section of midrib ×450
6. leaf base cells ×300

7. and 8. cross sections of leaf margin ×450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P l a t e XXXIV

Gr. apocarpa var. *tenerrima* NEES et HORNSCH.

1. and 2. cross sections of leaf margin $\times 450$
3. cross section of stem $\times 300$
4. leaf $\times 36$
5. leaf apex $\times 300$
6. cross section of midrib $\times 450$
7. plant habit $\times 7.5$
8. median leaf cells $\times 300$
9. leaf base cells $\times 300$

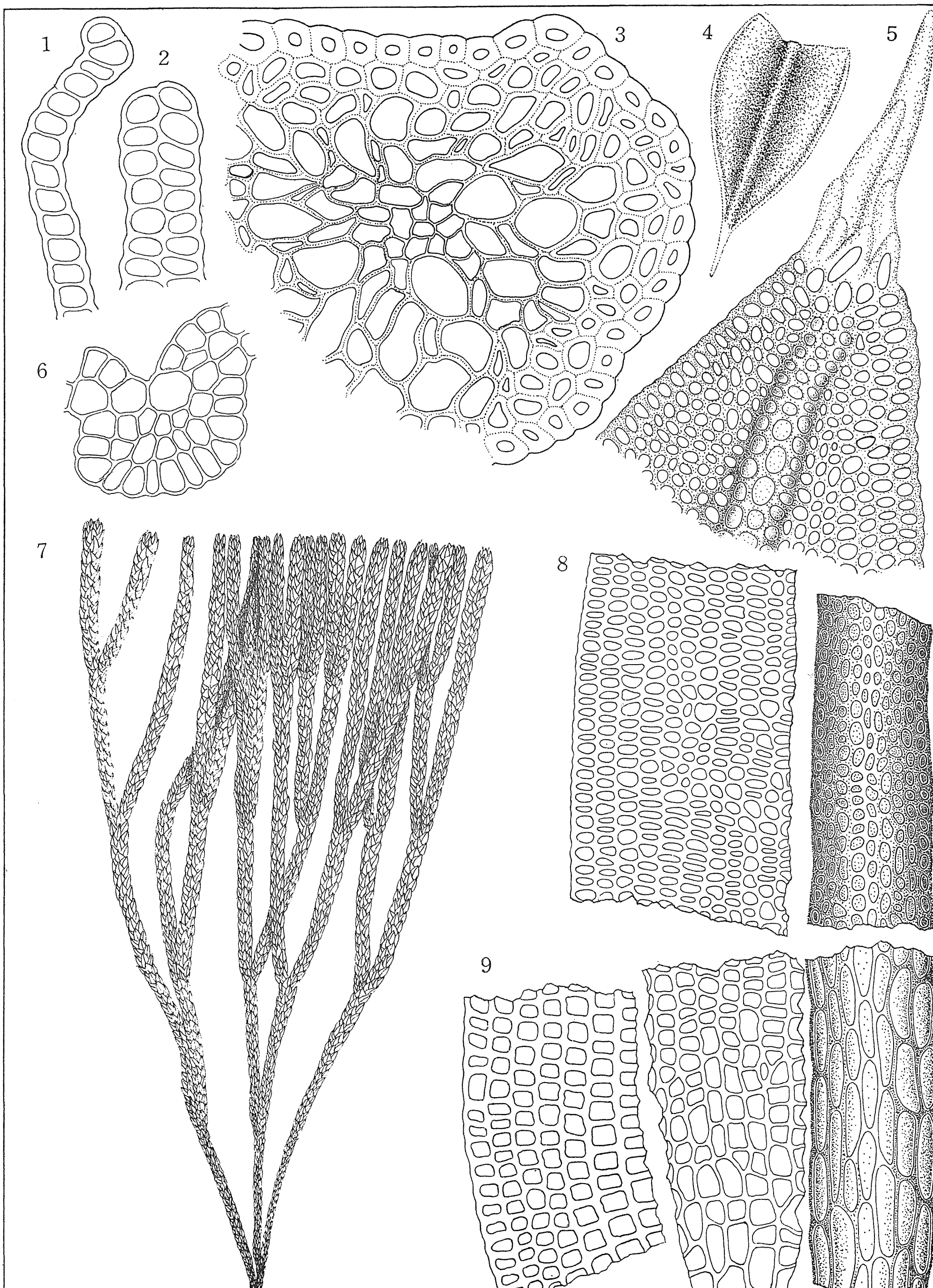
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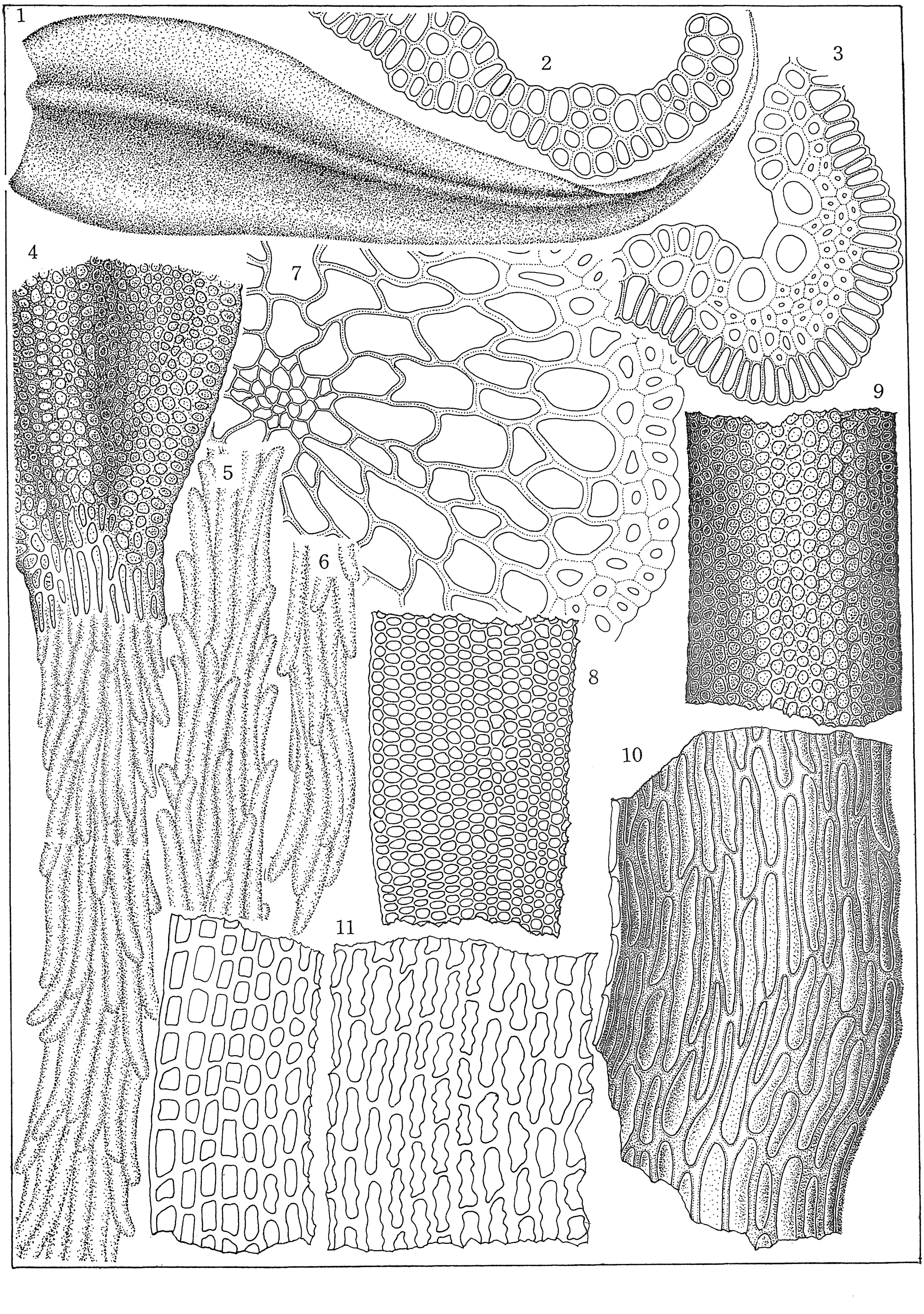
Plate XXXV

Gr. arizonae REN. et CARD.

1. leaf ×36
2. cross section of leaf margin ×450
3. cross section of midrib ×450
4. 5. and 6. leaf apexes ×300
7. cross section of stem ×300
8. margin cells of median leaf ×300
9. midrib cells of median leaf ×300
10. midrib cells of leaf base ×300
11. margin cells of leaf base ×300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P l a t e XXXVI

Gr. cratericola SAK. et TAK.

1. cross section of stem $\times 300$
2. and 3. cross sections of leaf margin $\times 450$
4. cross section of midrib $\times 450$
5. median leaf cells $\times 300$
6. plant habit $\times 7.5$
7. leaf $\times 36$
8. leaf apex $\times 300$
9. and 10. leaf base cells $\times 300$

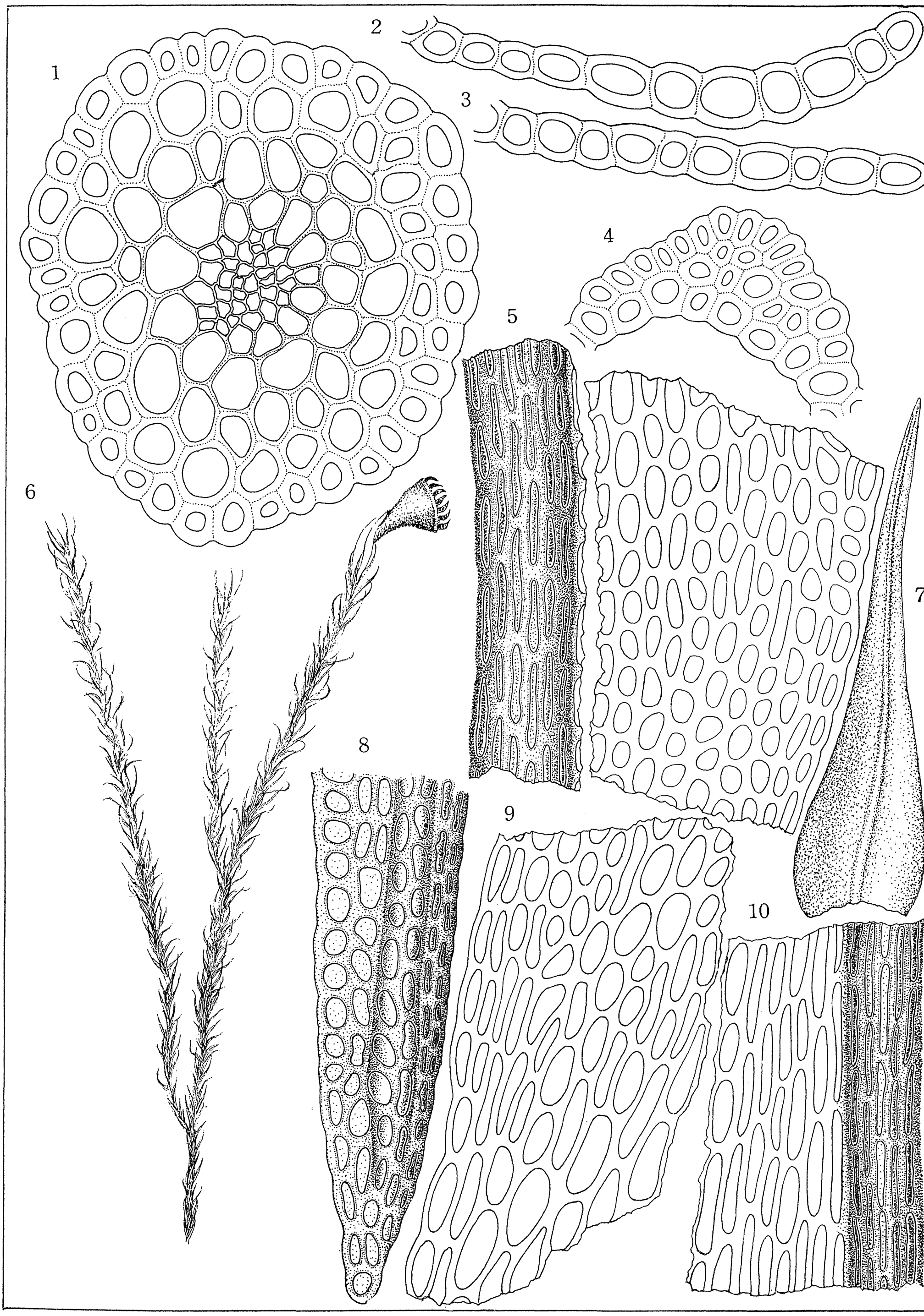
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Plate XXXVII

Gr. decalvata CARD.

1. cross section of stem ×450
2. leaf apex ×300
3. and 4. cross sections of leaf margin ×450
5. leaf ×36
6. median leaf cells ×300
7. leaf base cells ×300
8. cross section of midrib ×450

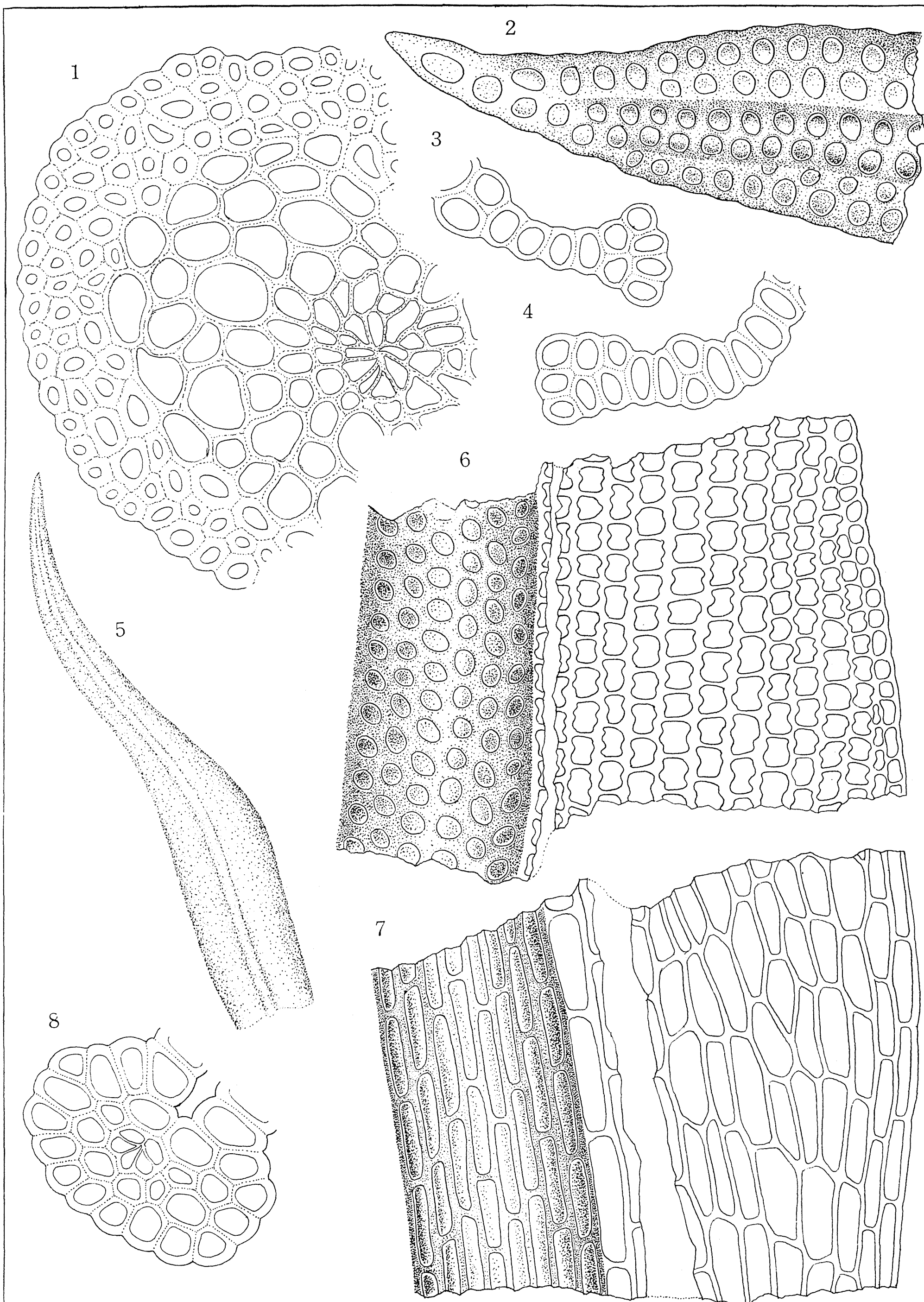
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Plate XXXVIII

Gr. decipiens (SCHULTZ.) LINDB.

1. leaf apex (apex of hyaline point) $\times 300$
2. leaf apex (median of hyaline point) $\times 300$
3. leaf apex (basal of hyaline point) $\times 300$
4. leaf $\times 36$
5. cross section of midrib $\times 450$
6. cross section of leaf margin $\times 450$
7. cross section of leaf margin $\times 450$
8. median leaf cells $\times 300$
9. leaf base cells $\times 300$
10. cross section of stem $\times 300$

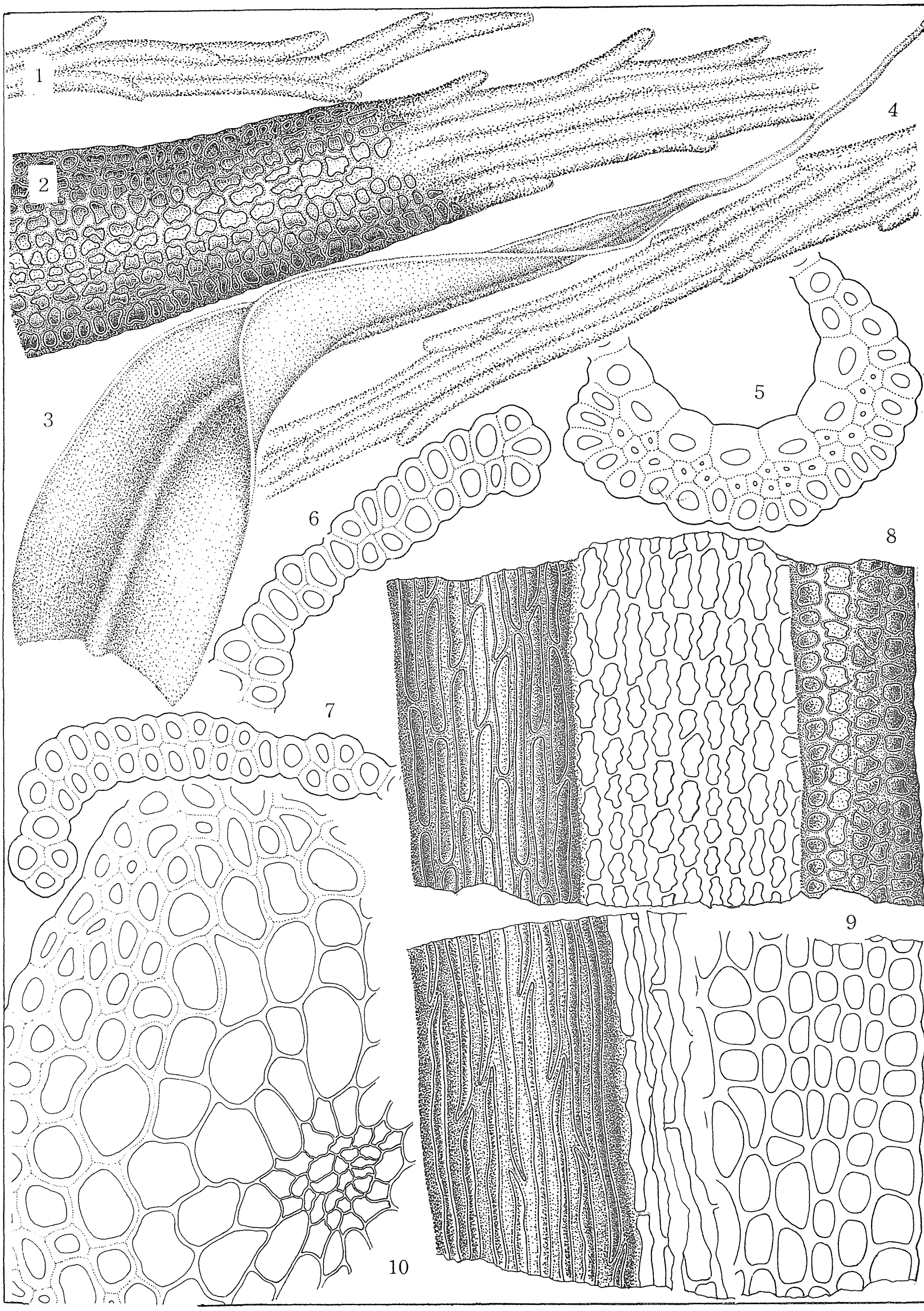
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Plate XXXIX

Gr. donniana SM.

1. cross section of stem $\times 300$
2. and 3. cross sections of leaf margin $\times 450$
4. cross section of midrib $\times 450$
5. leaf $\times 36$
6. leaf apex $\times 300$
7. plant habit $\times 7$
8. median leaf cells $\times 300$
9. leaf base cells $\times 300$

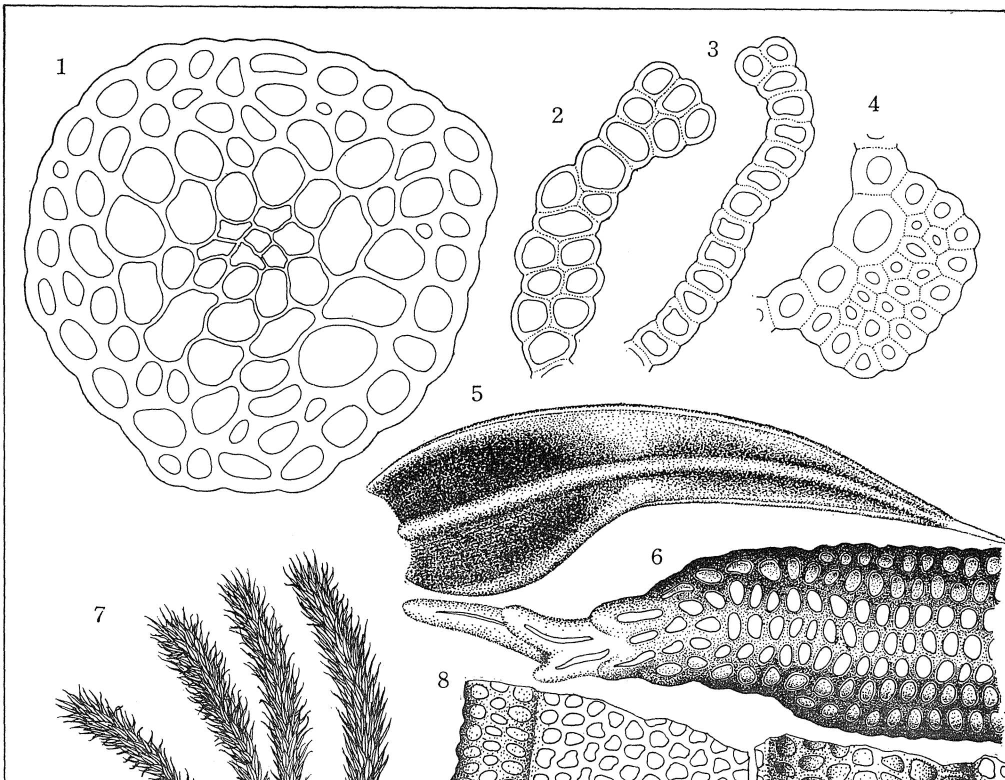
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Plate XL

Gr. elatior BRUCH

1. leaf apex $\times 300$
2. leaf $\times 36$
3. median leaf cells $\times 300$
4. cross section of stem $\times 300$
5. leaf base cells $\times 300$
6. cross section of leaf margin $\times 450$
7. cross section of midrib $\times 450$

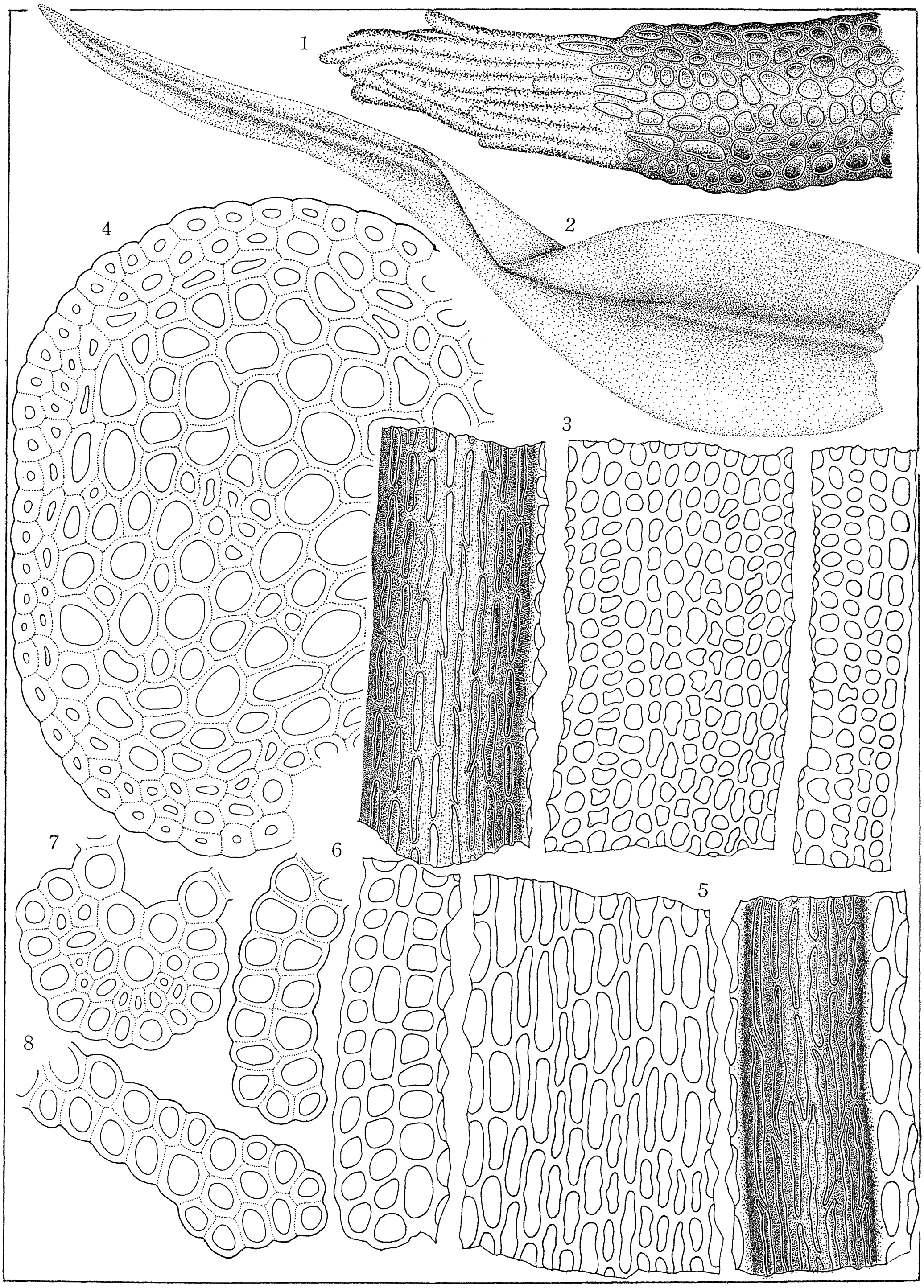
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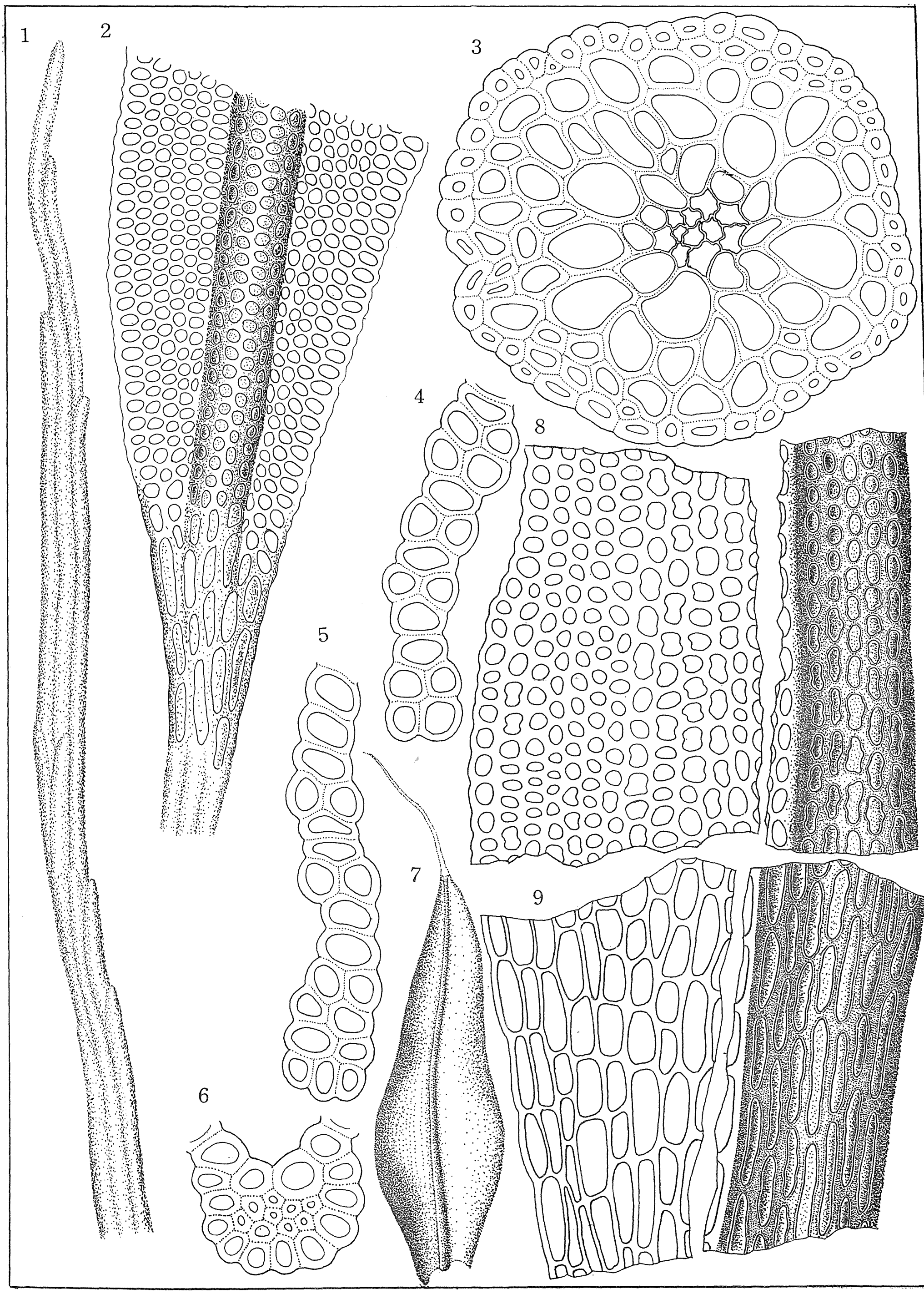
Plate XLI

Gr. funalis (SCHWAEGR.) B. S. G.

1. and 2. leaf apexes $\times 300$
3. cross section of stem $\times 300$
4. and 5. cross sections of leaf margin $\times 450$
6. cross section of midrib $\times 450$
7. leaf $\times 36$
8. median leaf cells $\times 300$
9. leaf base cells $\times 300$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P l a t e XLII

Gr. funalis var. *calvescens* (KINDB.) MOELL.

1. 3. and 4. cross sections of leaf margin $\times 450$
2. cross section of midrib $\times 450$
5. leaf apex $\times 300$
6. cross section of stem $\times 300$
7. leaf $\times 36$
8. plant habit $\times 10$
9. median leaf cells $\times 300$
10. leaf base cells $\times 300$

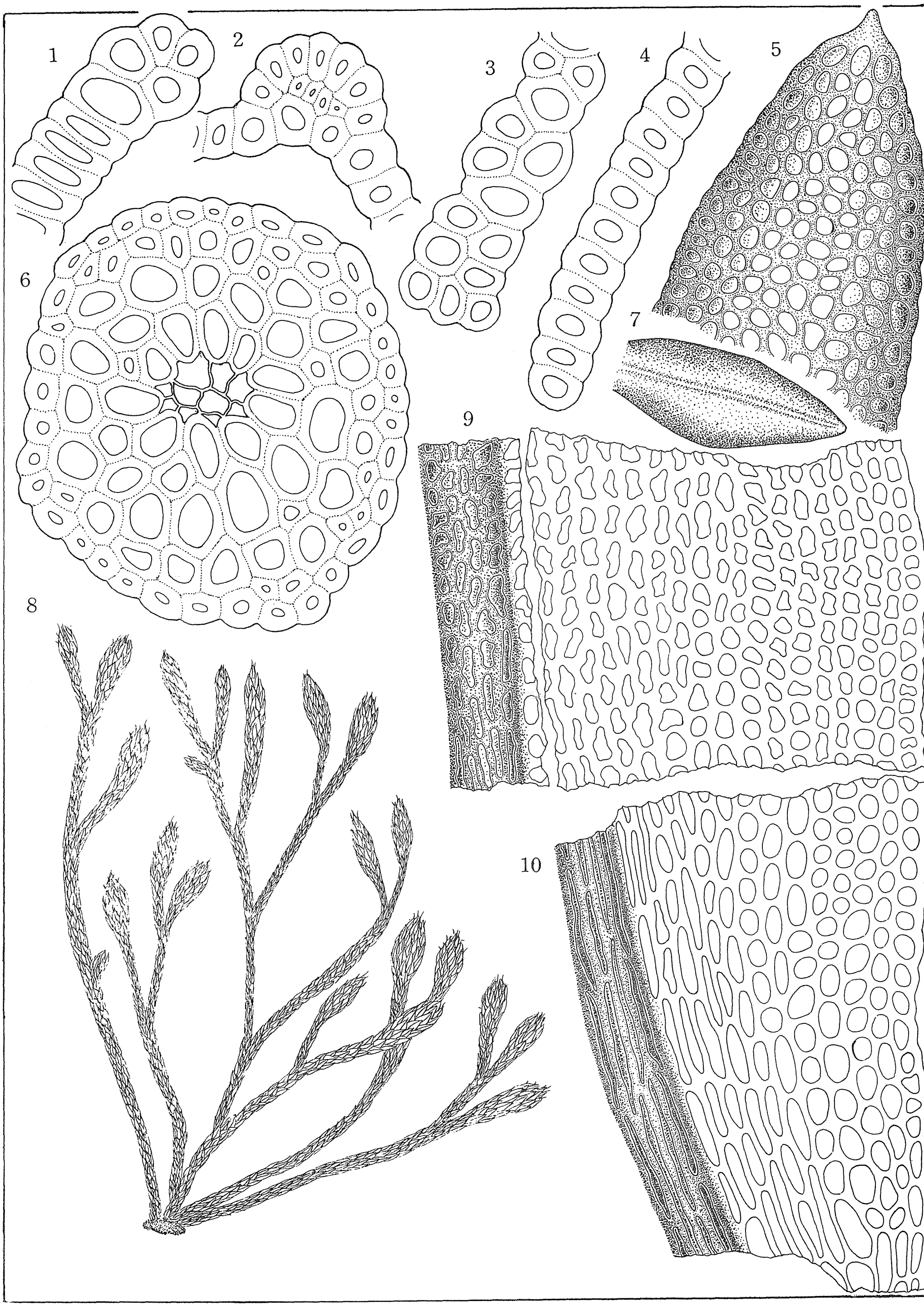
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Plate XLIII

Gr. funalis f. *longipila* BOUL.

1. 2. 3. and 4. leaf apexes ×300
5. leaf ×36
6. and 7. cross sections of leaf margin ×450
8. cross section of midrib ×450
9. median leaf cells ×300
10. leaf base cells ×300
11. corss section of stem ×300

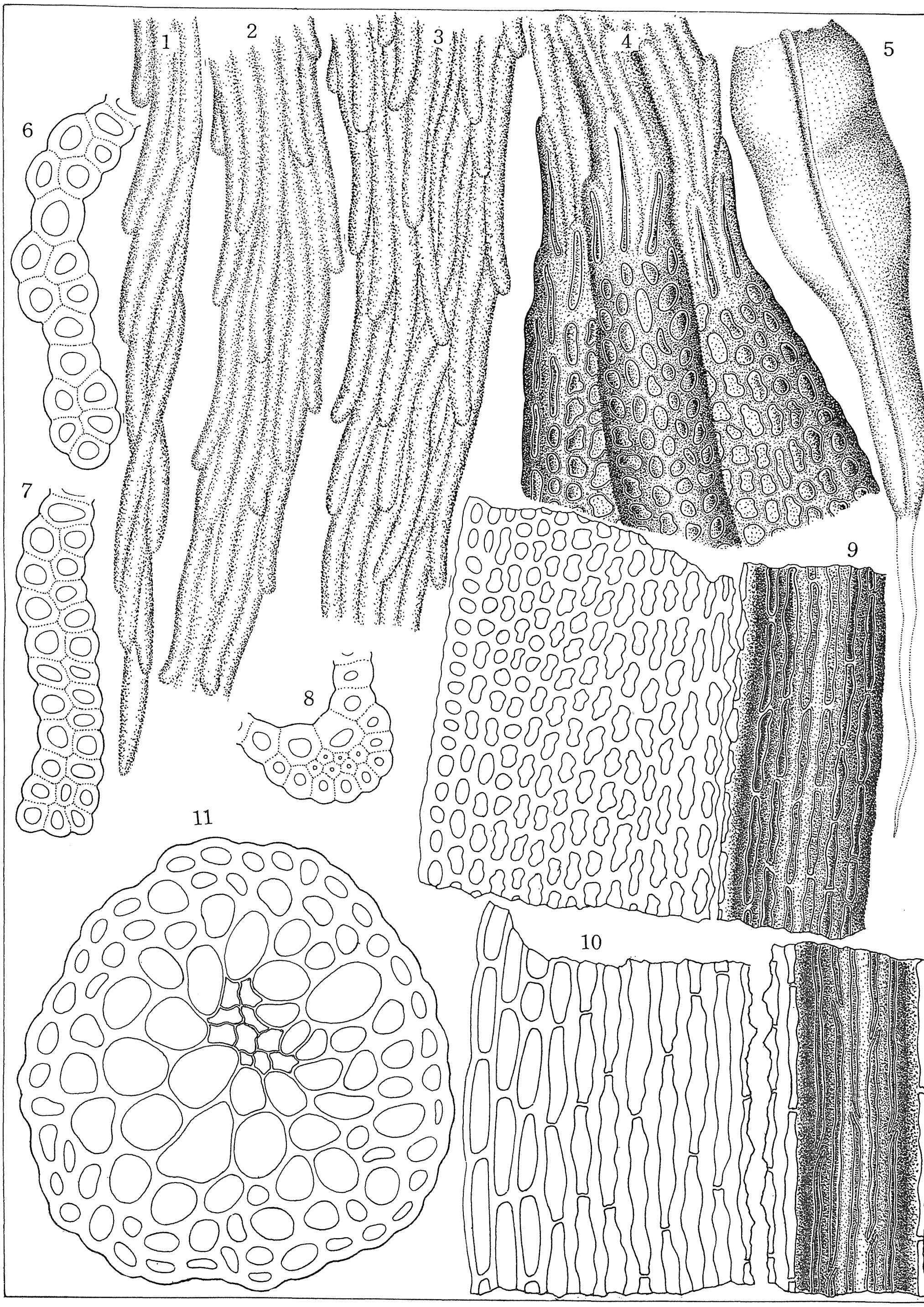
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Plate XLIV

Gr. hartmanii SCHIMP.

1. leaf ×36
2. cross section of midrib ×450
3. leaf apex ×300
4. median leaf cells ×300
5. leaf base cells ×300
6. plant habit ×5
7. cross section of stem ×450
8. and 9. cross sections of leaf margin ×450
10. leaf ×36

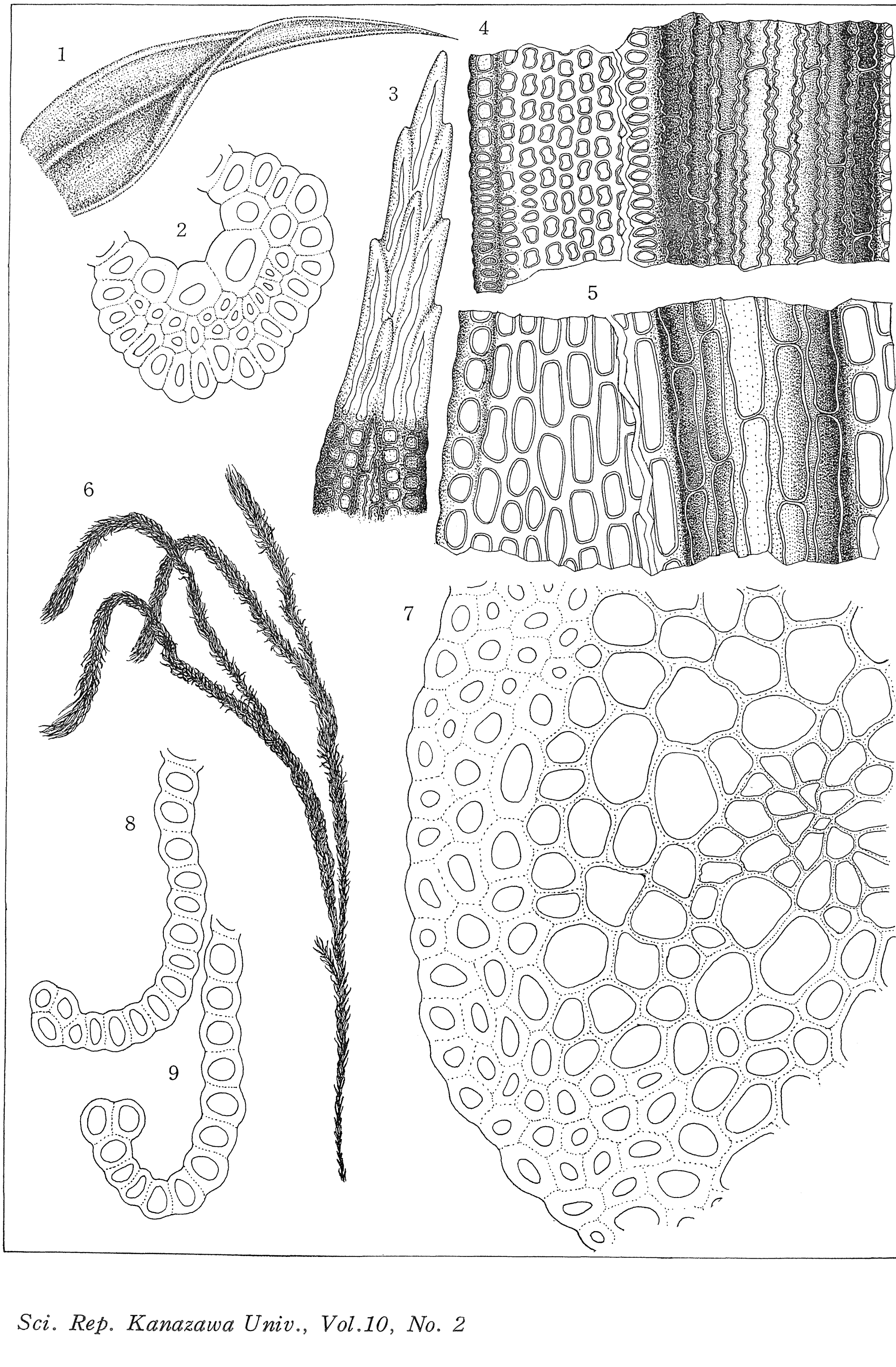
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Plate XLV

Gr. incurva SCHWAEGR.

1. cross section of stem ×300
2. leaf apex ×300
3. leaf ×36
4. and 7. cross sections of leaf margin ×450
5. cross section of midrib ×450
6. plant habit ×12
8. median leaf cells ×300
9. leaf base cells ×300

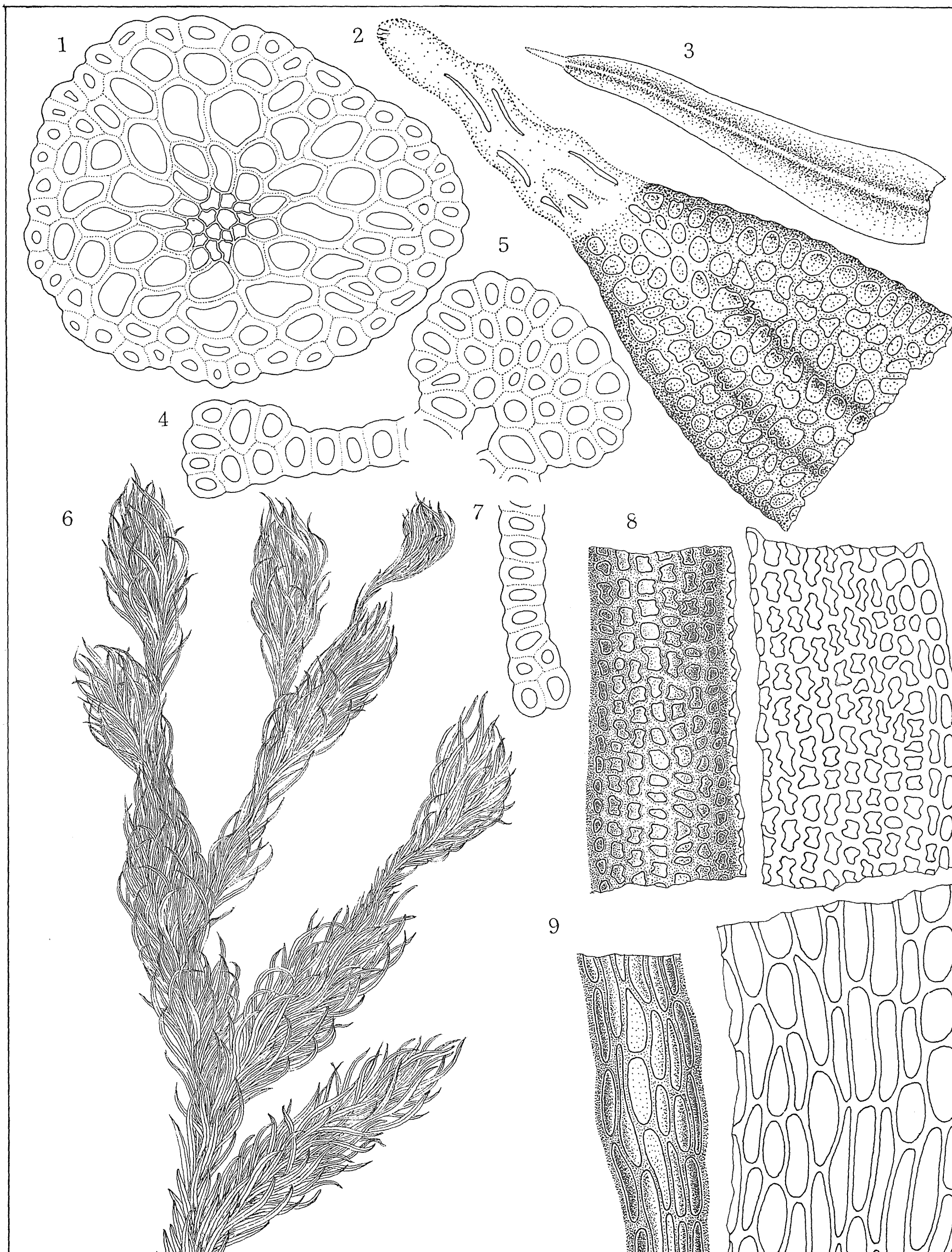
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Plate XLVI

Gr. laevigata (BRID.) BRID.

1. leaf ×36
2. cross section of midrib ×450
3. and 4. cross sections of leaf margin ×450
5. cross section of stem ×300
6. 7. and 8. leaf apex ×300
9. median leaf cells ×300
10. midrib cells of leaf base ×300
11. margin cells of leaf base ×300

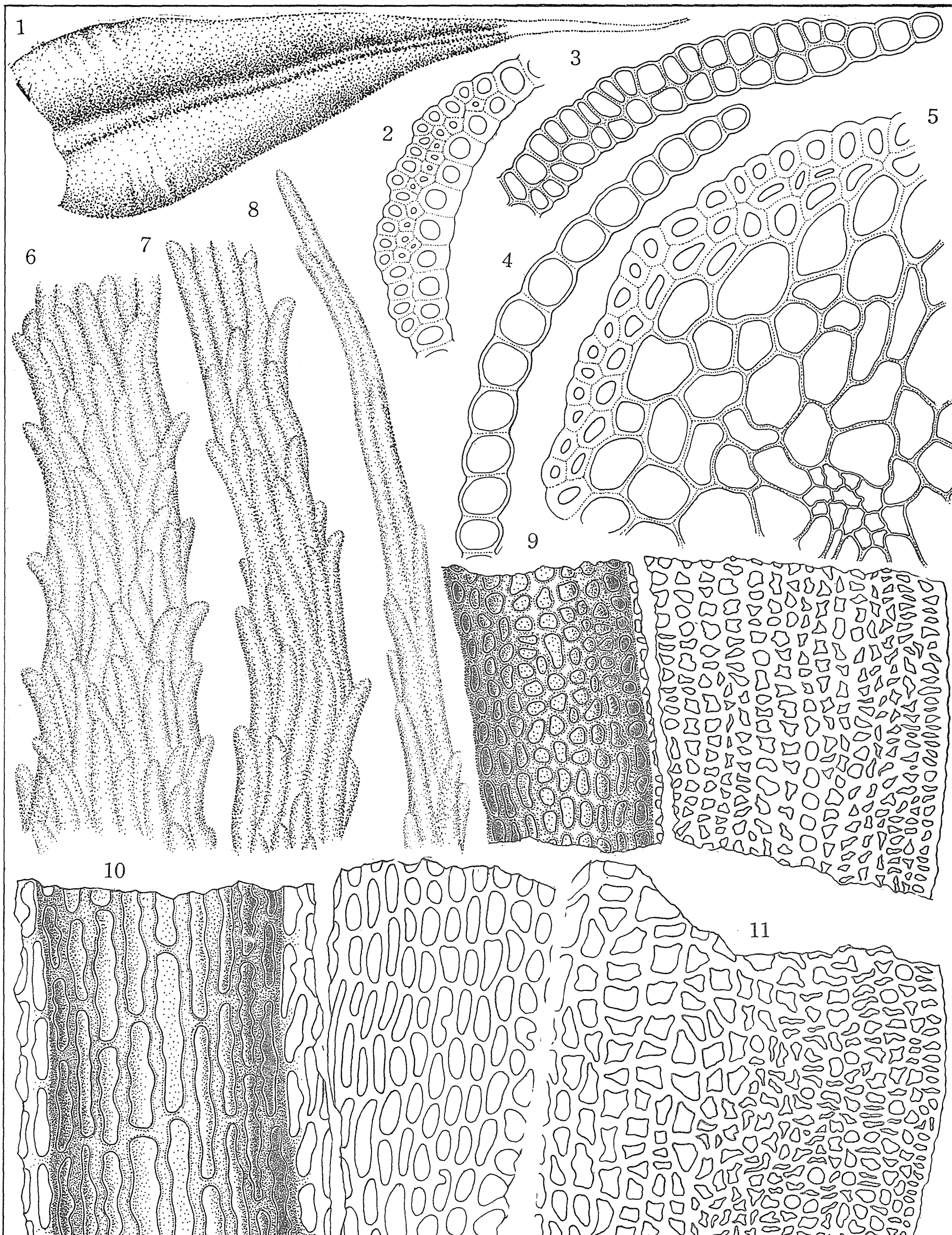
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Plate XLVII

Gr. maritima TURN.

1. cross section of midrib $\times 450$
2. cross section of stem $\times 300$
3. leaf apex $\times 300$
4. leaf $\times 36$
5. and 6. cross sections of leaf margin $\times 450$
7. median leaf cells $\times 300$
8. leaf base cells $\times 300$

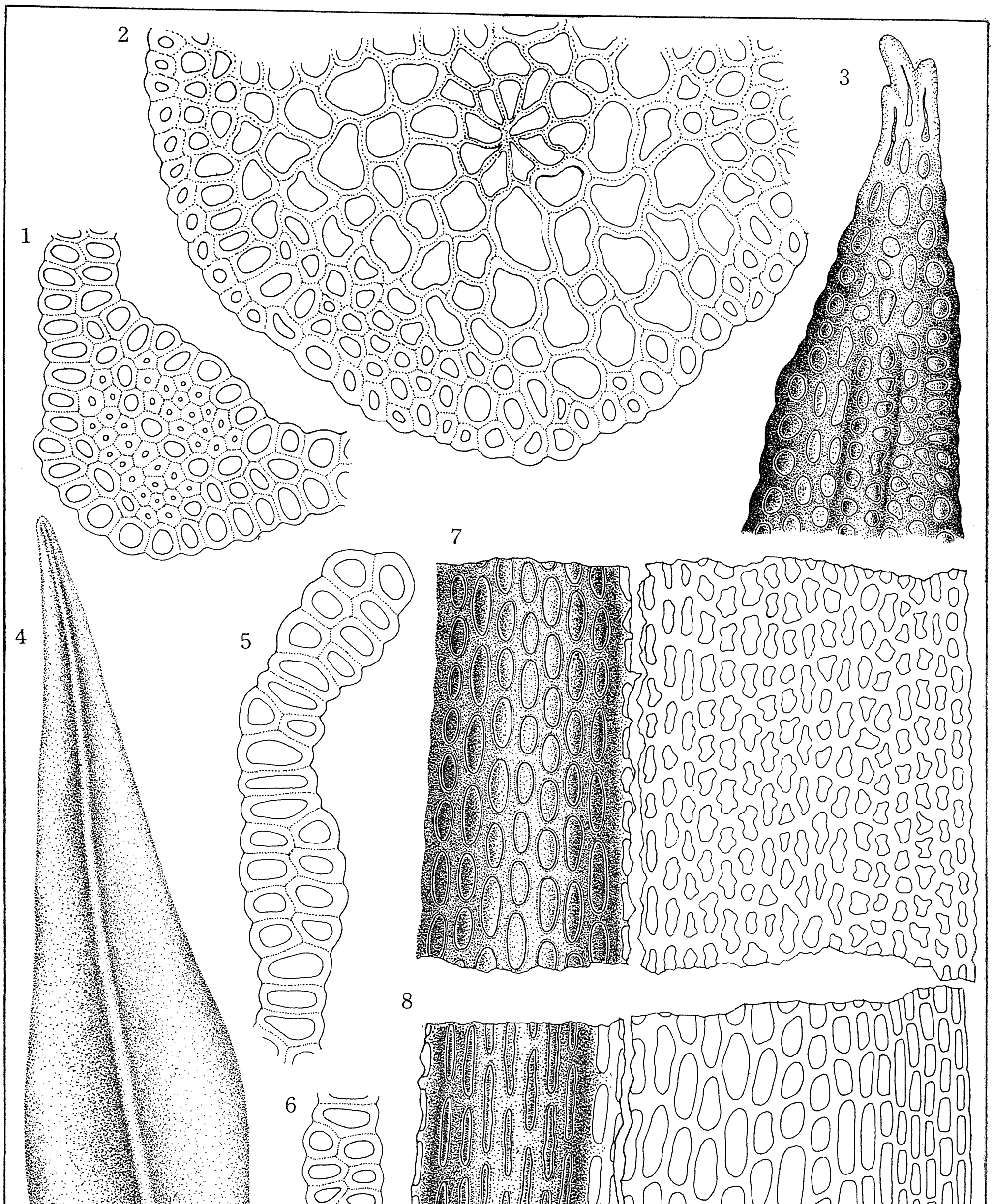
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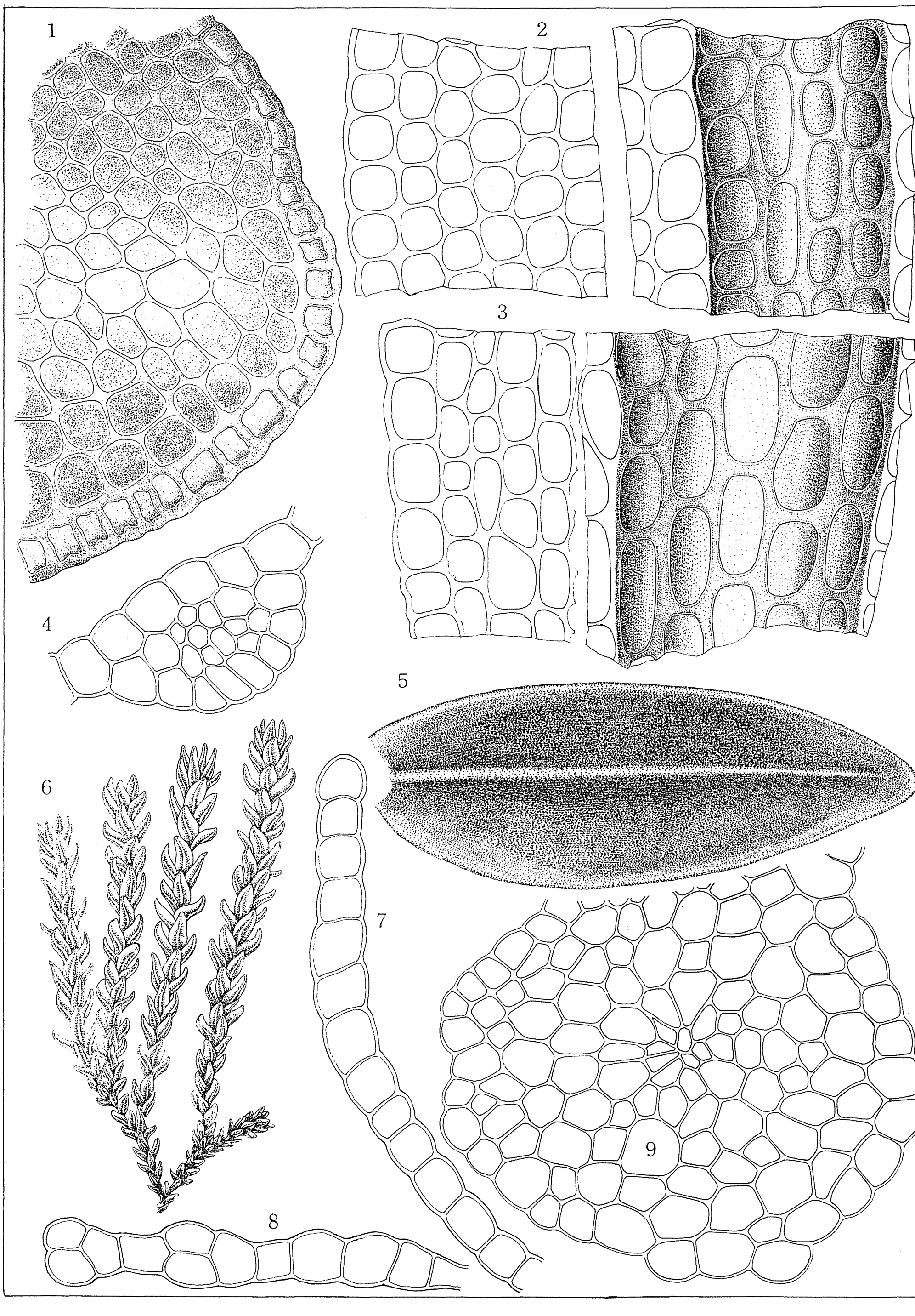
Plate XLVIII

Gr. mollis B. S. G.

1. leaf apex ×300
2. median leaf cells ×300
3. leaf base cells ×300
4. cross section of midrib ×450
5. leaf ×36
6. plant habit ×7.5
7. and 8. cross sections of leaf margin ×450
9. cross section of stem ×300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P l a t e XLIX

Gr. orbicularis var. *persica* SCHIFFNER

1. 2. and 3. leaf apexes $\times 300$
4. leaf $\times 36$
5. leaf base cells $\times 300$
6. median leaf cells $\times 300$
7. cross section of stem $\times 300$
8. cross section of midrib $\times 450$
9. cross section of leaf margin $\times 450$

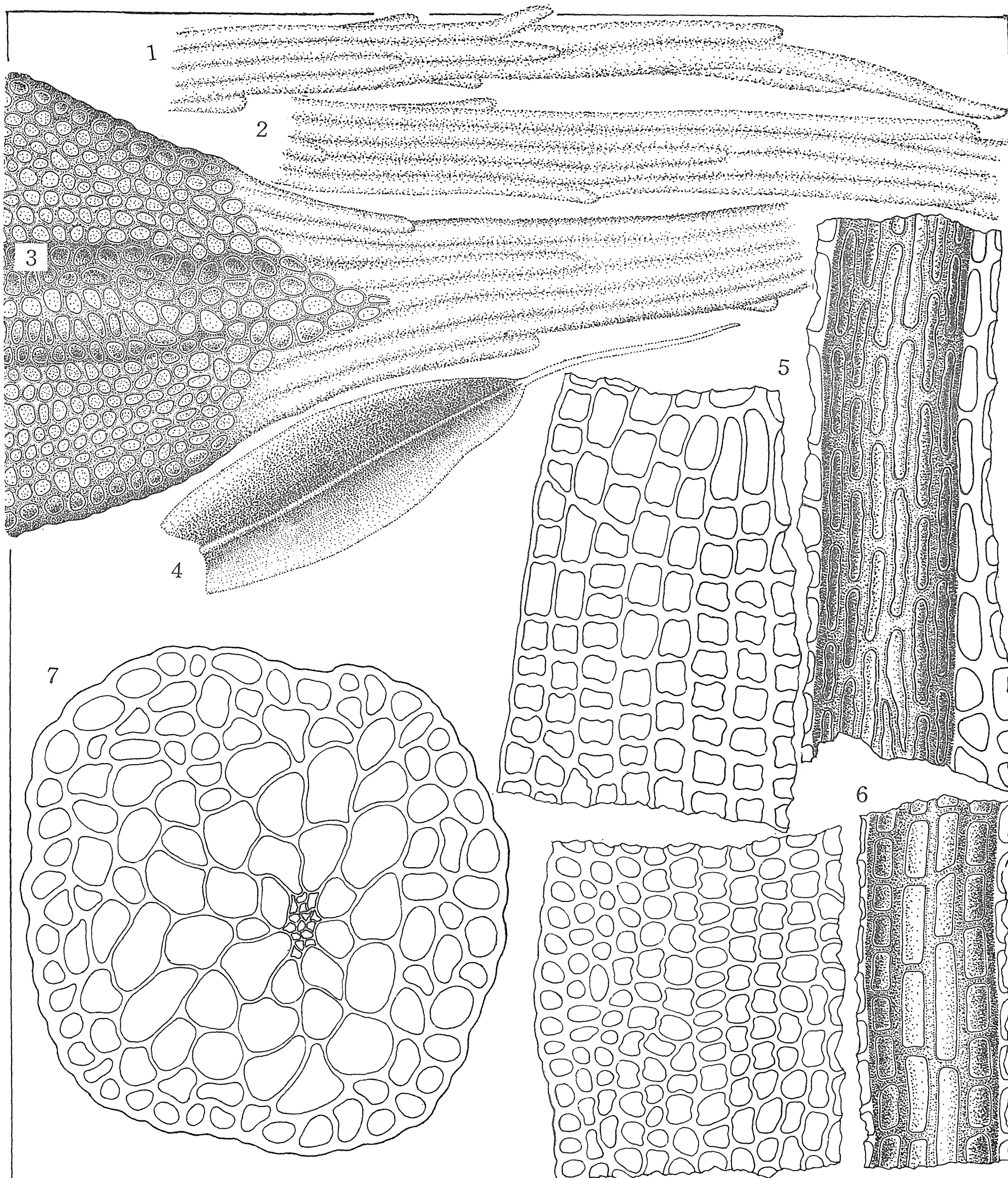
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Plate L

Gr. ovalis (HEDW.) LINDB.

1. plant habit $\times 7$
2. leaf $\times 36$
3. female plant with capsule $\times 15$
4. leaf apex $\times 150$
5. median leaf cells $\times 300$
6. leaf base cells $\times 300$
7. cross section of midrib $\times 450$
8. cross section of leaf margin $\times 450$
9. cross section of stem $\times 300$

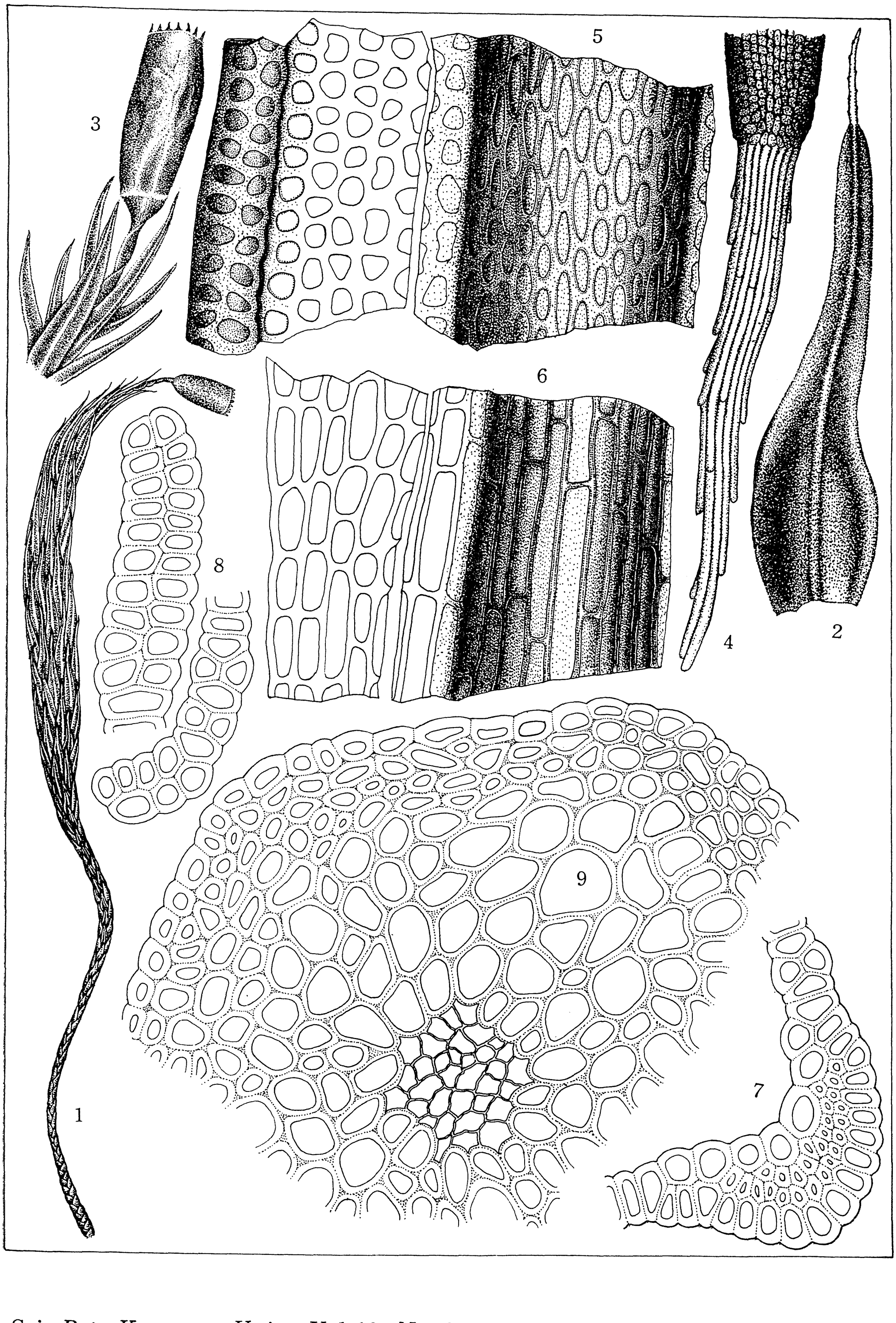
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Plate LI

Gr. patens (HEDW.) B. S. G.

1. cross section of stem $\times 300$
2. leaf base cells $\times 300$
3. median leaf cells $\times 300$
4. leaf apex $\times 300$
5. and 6. leaves $\times 36$
7. cross section of leaf margin $\times 450$
8. cross section of midrib $\times 450$

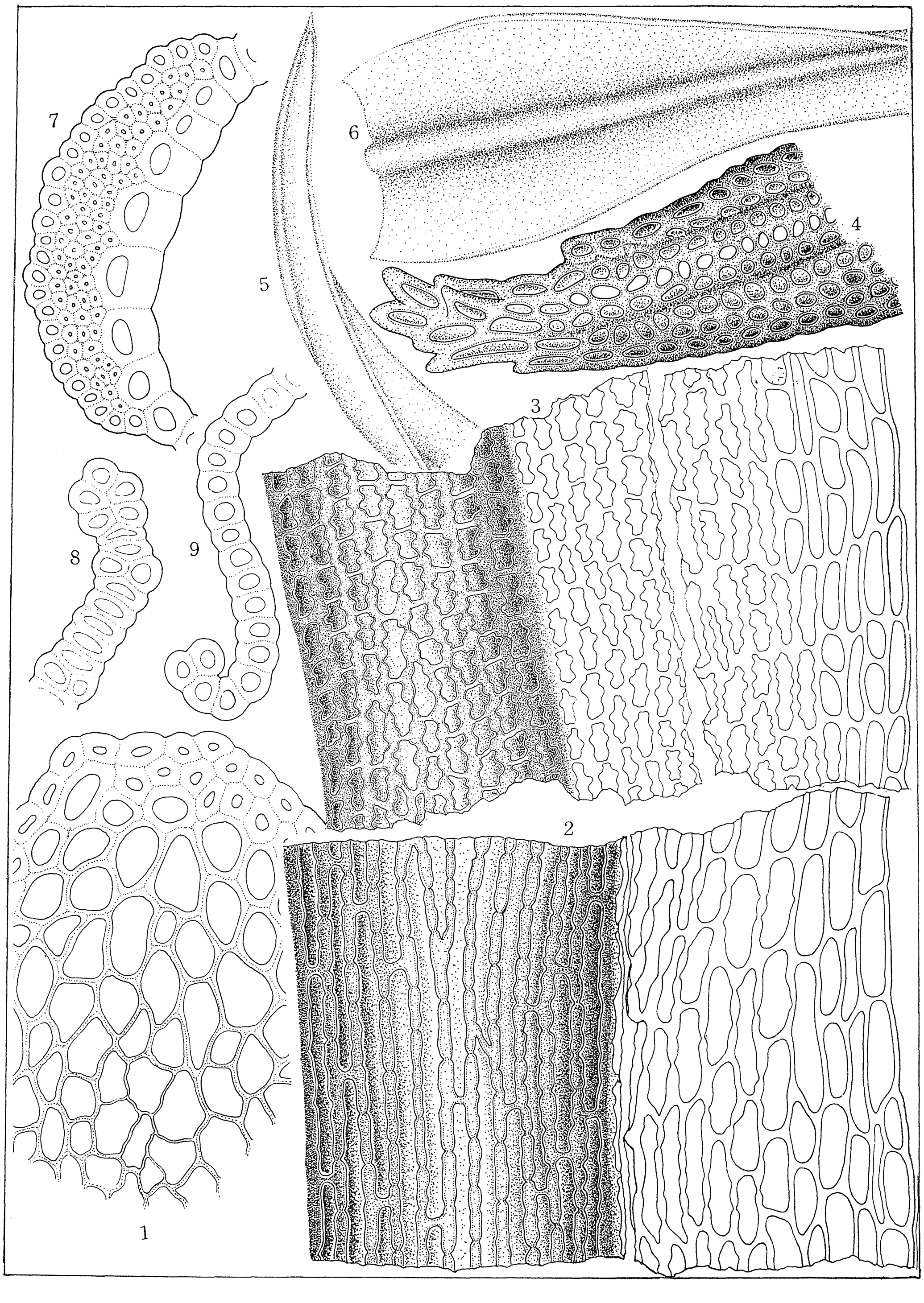
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Plate LII

Gr. pilifera P. BEAUV.

1. plant habit ×7
2. leaf ×36
3. female plant with capsule ×15
4. leaf apex ×300
5. median leaf cells ×300
6. leaf base cells ×300
7. cross section of midrib ×450
8. cross section of leaf margin ×450
9. cross section of stem ×300
10. peristom teeth ×150

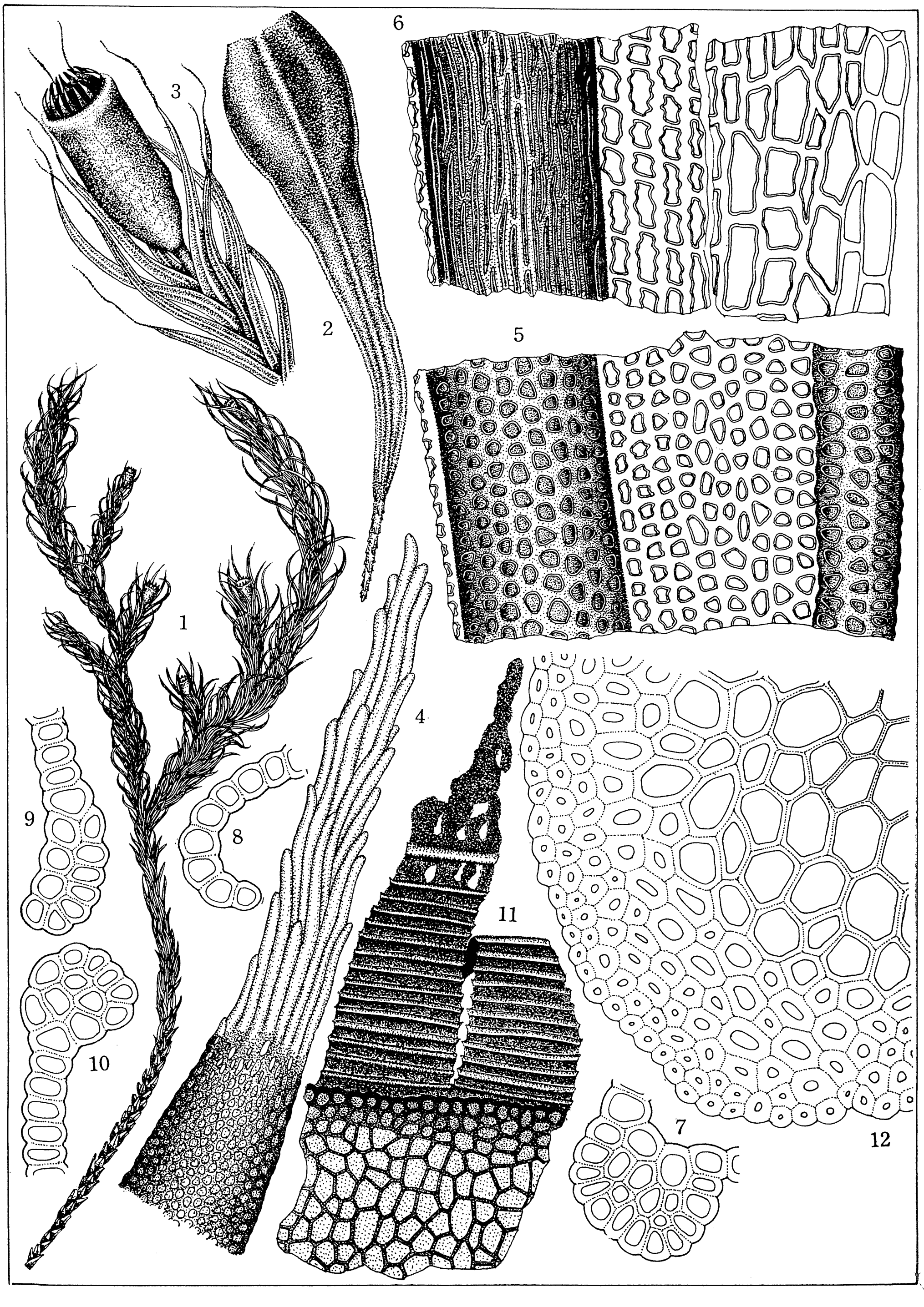
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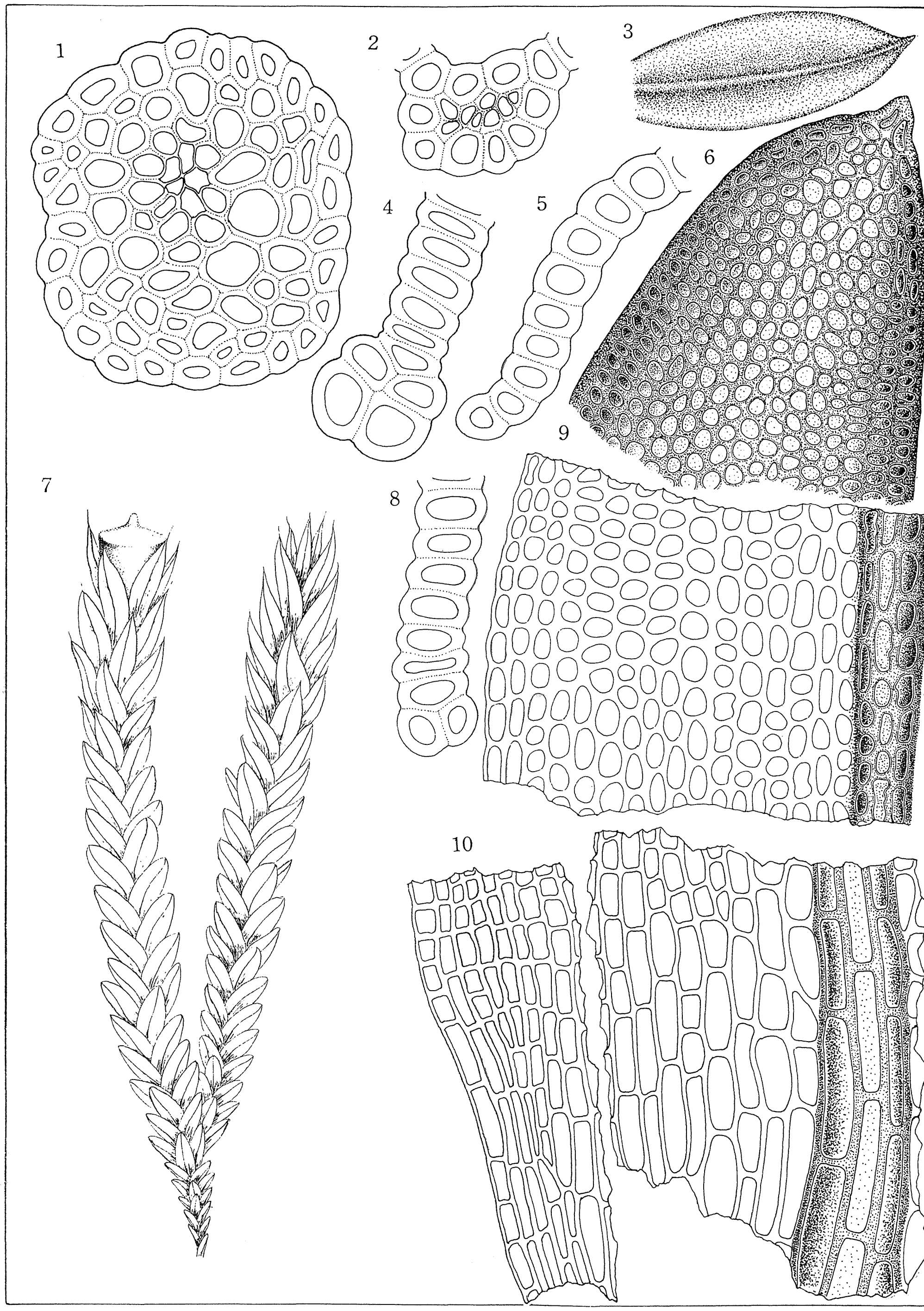
Plate LIII

Gr. plagiopodia HEDW.

1. cross section of stem $\times 300$
2. cross section of midrib $\times 450$
3. leaf $\times 36$

4\. 5. and 8. cross sections of leaf margin $\times 450$

6. leaf apex $\times 300$
7. plant habit $\times 22$
9. median leaf cells $\times 300$
10. leaf base cells $\times 300$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P l a t e LIV

Gr. pulvinata (HEDW.) SM.

1. plant habit $\times 7$
2. leaf $\times 36$
3. female plant with capsule $\times 15$
4. leaf apex $\times 150$
5. median leaf cells $\times 300$
6. leaf base cells $\times 300$
7. cross section of midrib $\times 450$
8. cross section of leaf maring $\times 450$
9. cross section of stem $\times 300$
10. calyptra $\times 36$

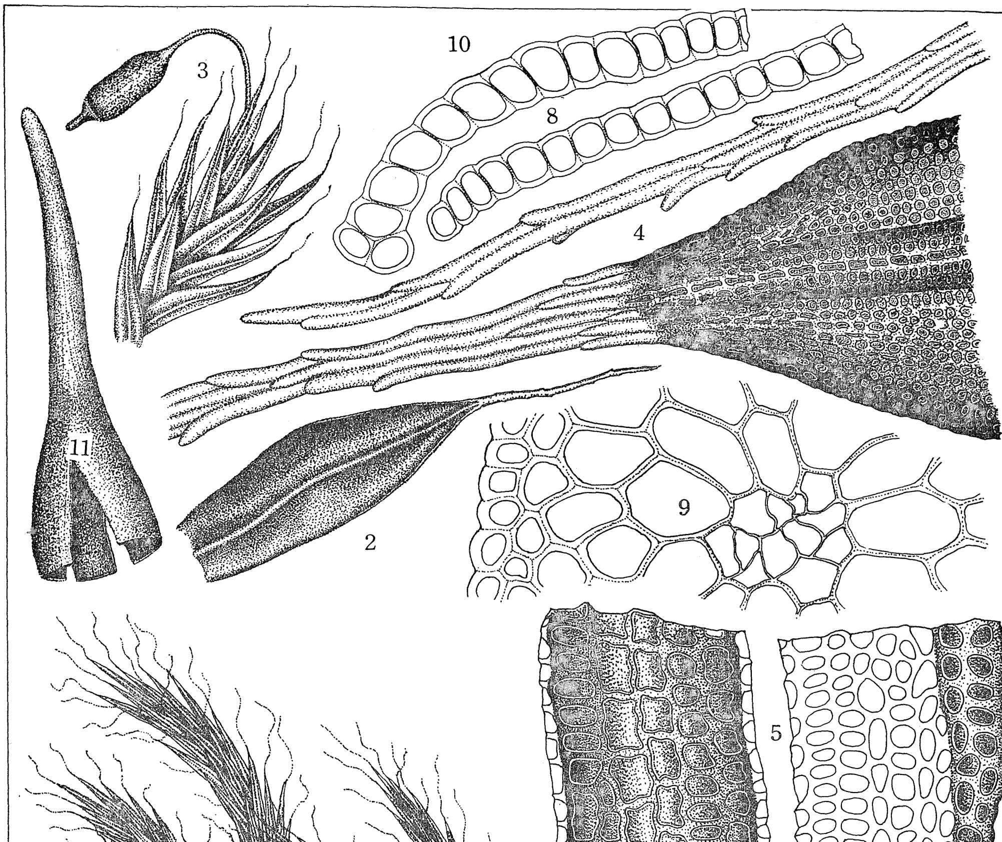
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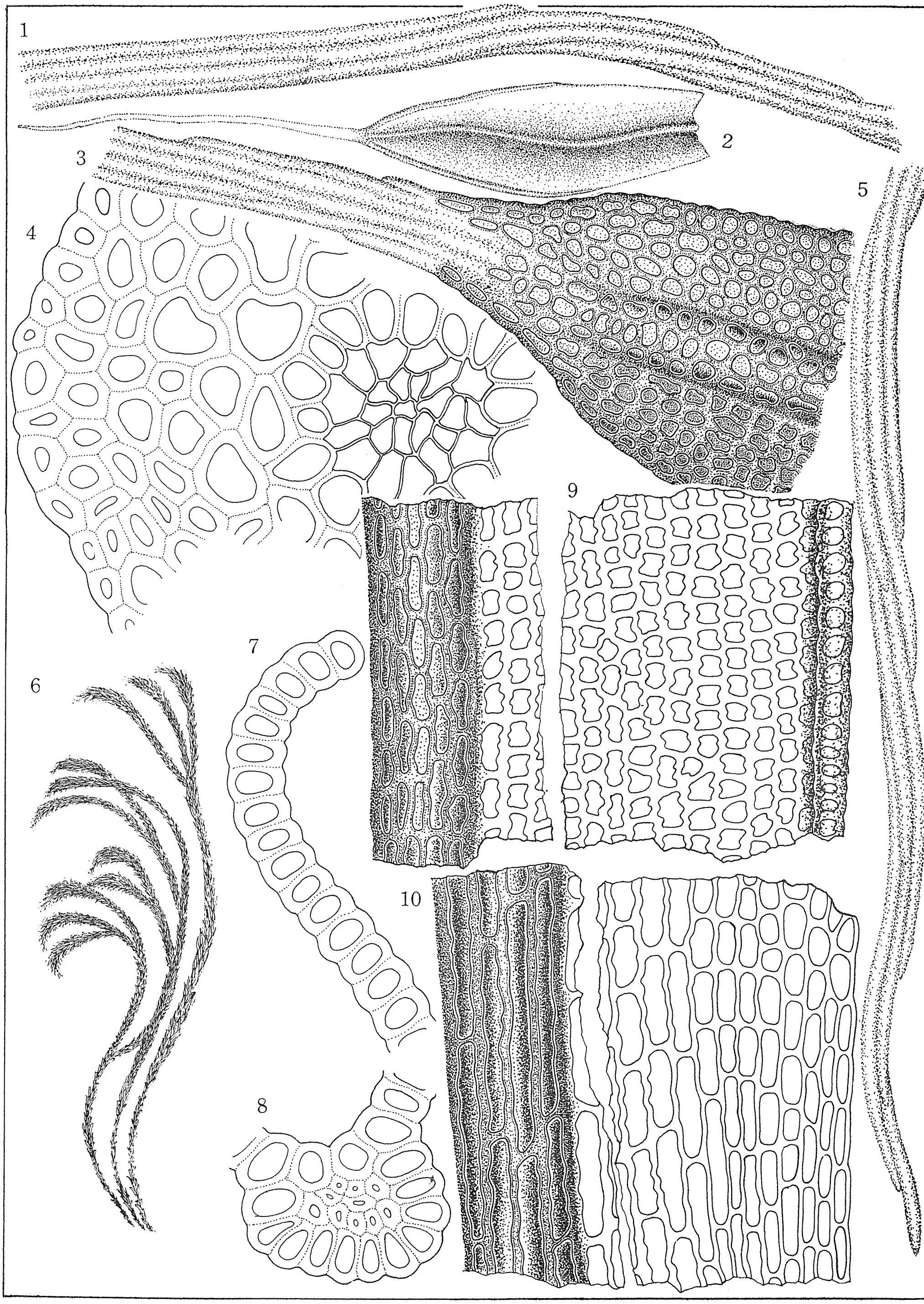
Plate LV

Gr. pulvinata var. *africana* (HEDW.) HOOK. f. et WILS.

1. 3. and 5. leaf apexes ×300
2. leaf ×36
4. cross section of stem ×300
6. plant habit ×3.6
7. cross section of leaf margin ×450
8. cross section of midrib ×450
9. median leaf cells ×300
10. leaf base cells ×300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P l a t e LVI

Gr. teretinervis LIMPR.

1. plant habit ×7.5
2. leaf ×36
3. leaf apex ×300
4. median leaf cells ×300
5. leaf base cells ×300
6. cross section of stem ×300
7. and 8. cross sections of leaf margin ×450
9· cross section of midrib ×450

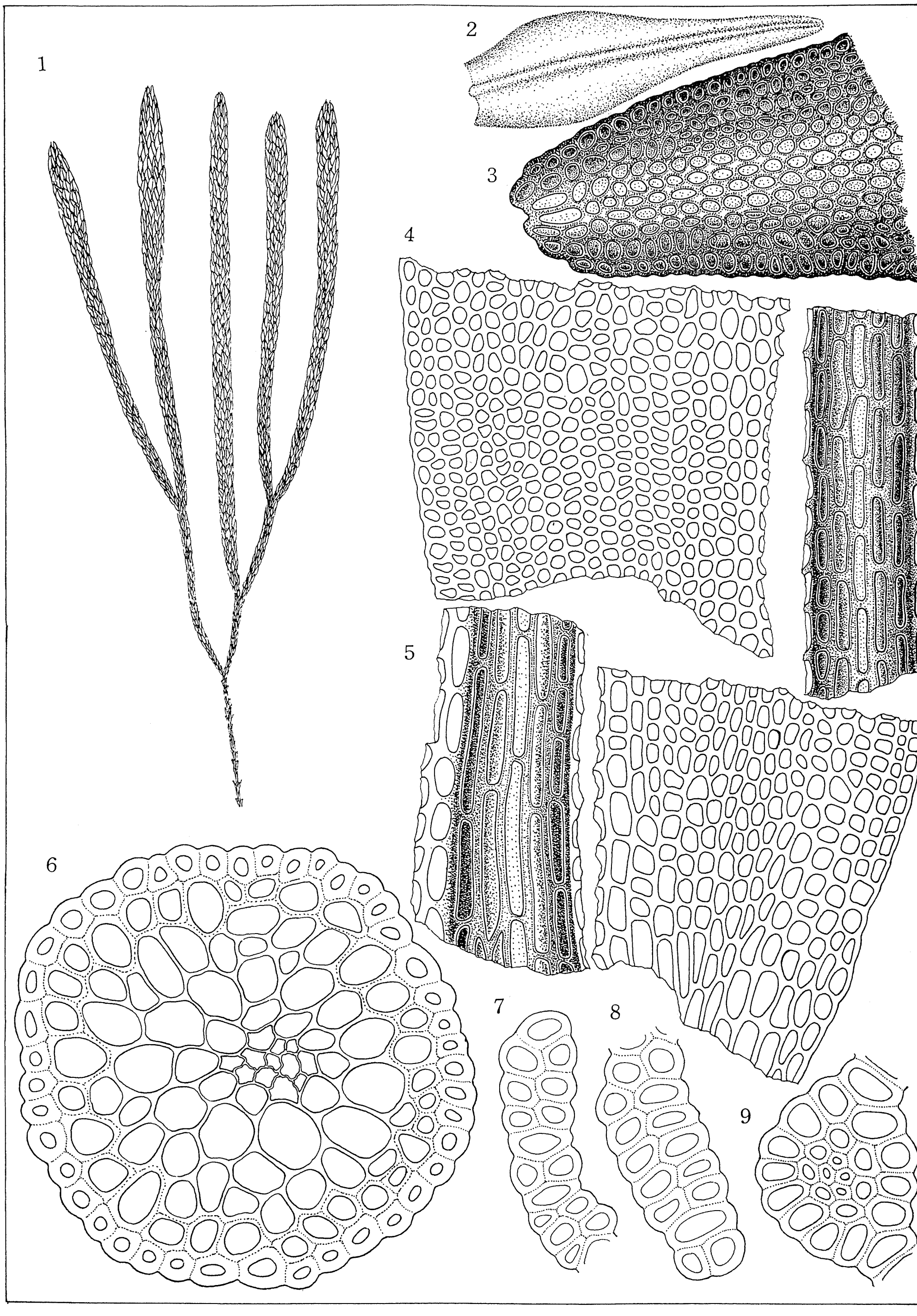
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Plate LVII

Gr. trichophylla ssp. *lisae* (De Not.) Boul.

1. plant habit ×7.5
2. and 3. leaf apexes ×300
4. median leaf cells ×300
5. leaf base cells ×300
6. cross section of stem ×300
7. and 8. cross sections of leaf margin ×450
9. cross section of midrib ×450
10. leaf ×36

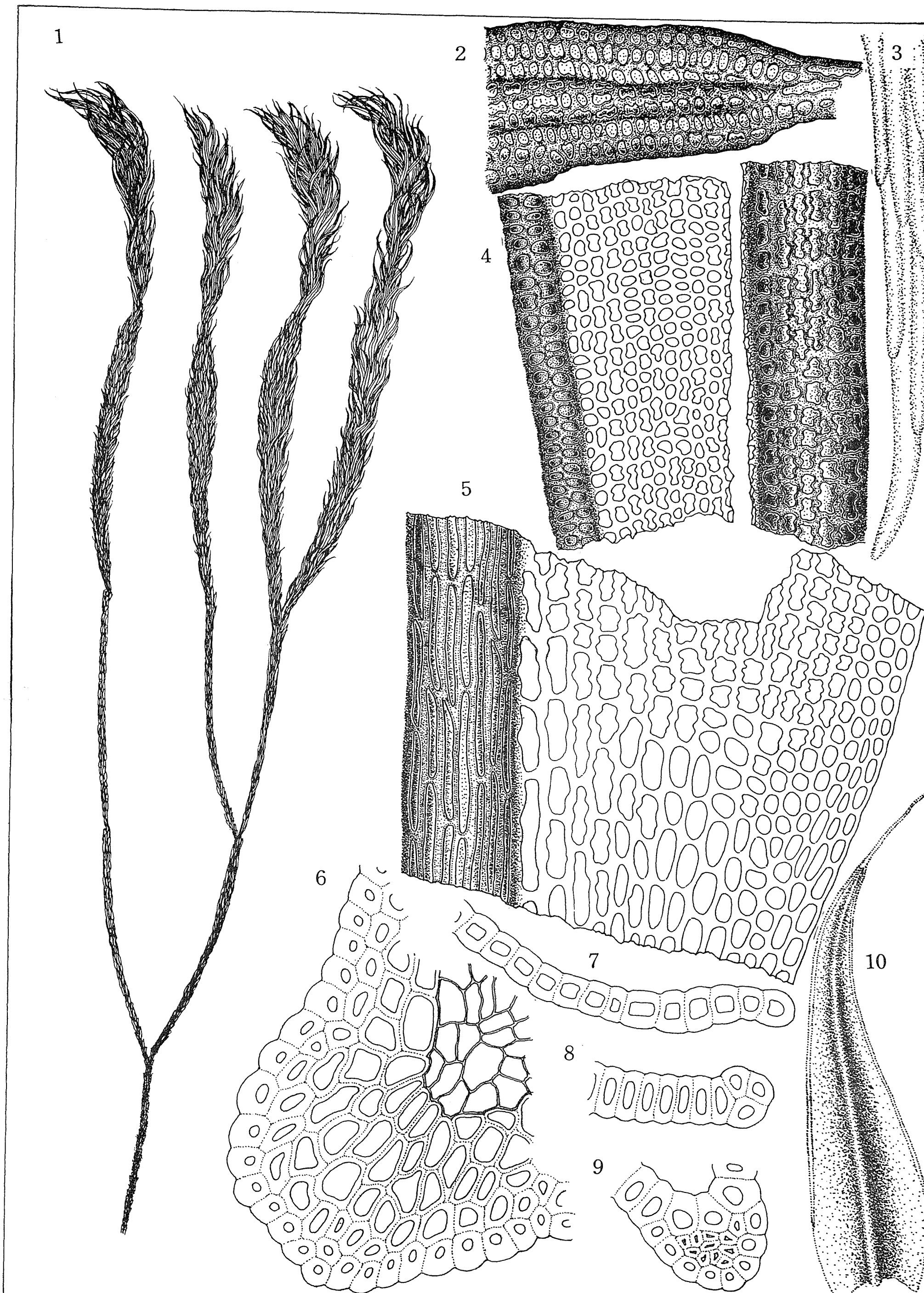
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Plate LVIII

Gr. trichophylla f. *robusta* Podp.

1. leaf apex $\times 300$
2. leaf $\times 36$
3. cross section of stem $\times 300$
4. median leaf cells $\times 300$
5. leaf base cells $\times 300$
6. cross section of midrib $\times 450$

7. and 8. cross sections of leaf margin $\times 450$

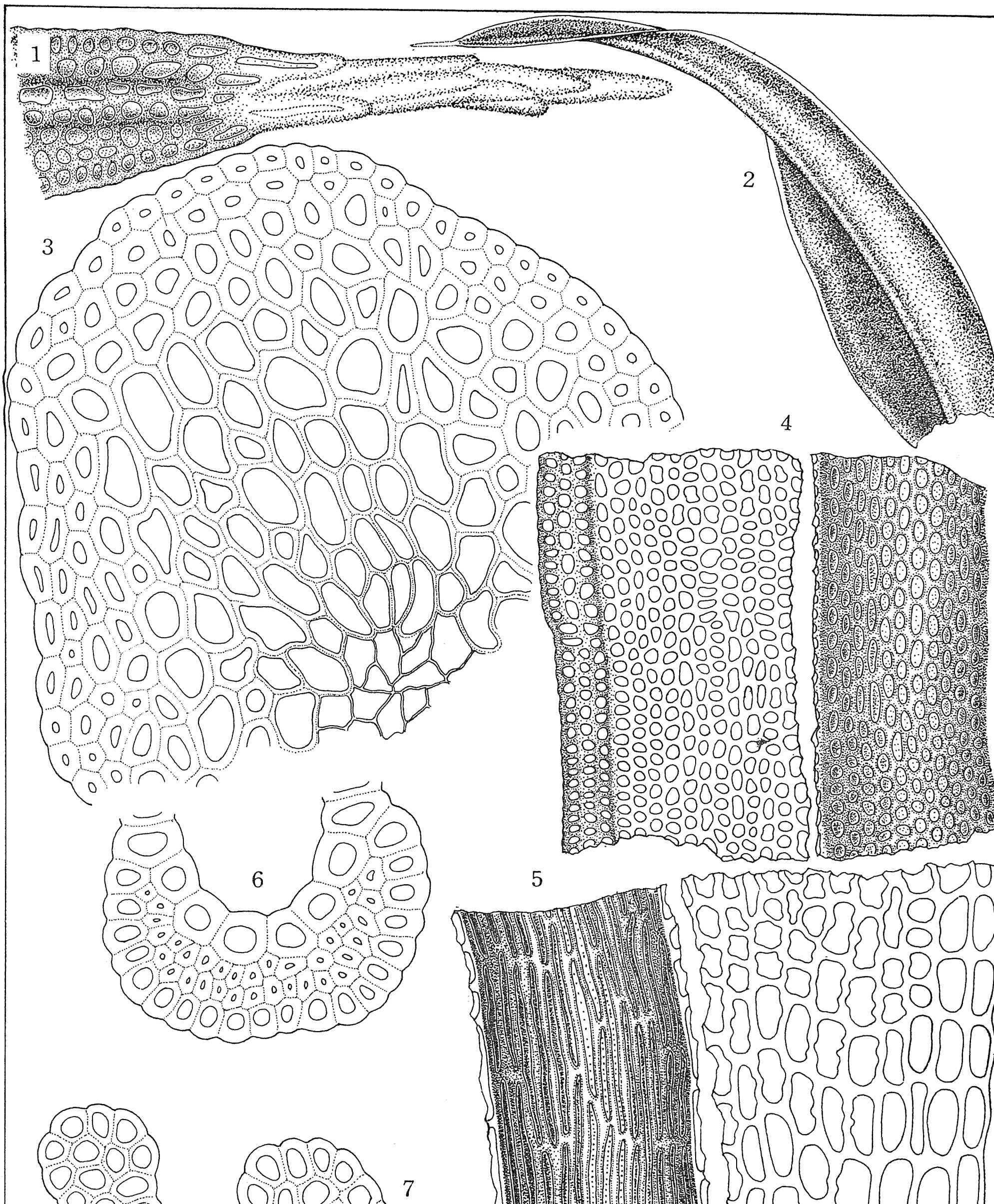
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Plate LIX

Gr. torquata GREV.

1. plant habit $\times 3$
2. leaf apex $\times 300$
3. leaf $\times 36$
4. median leaf cells $\times 300$
5. leaf base cells $\times 300$
6. cross section of stem $\times 300$
7. cross section of midrib $\times 450$
8. cross section of leaf margin $\times 450$

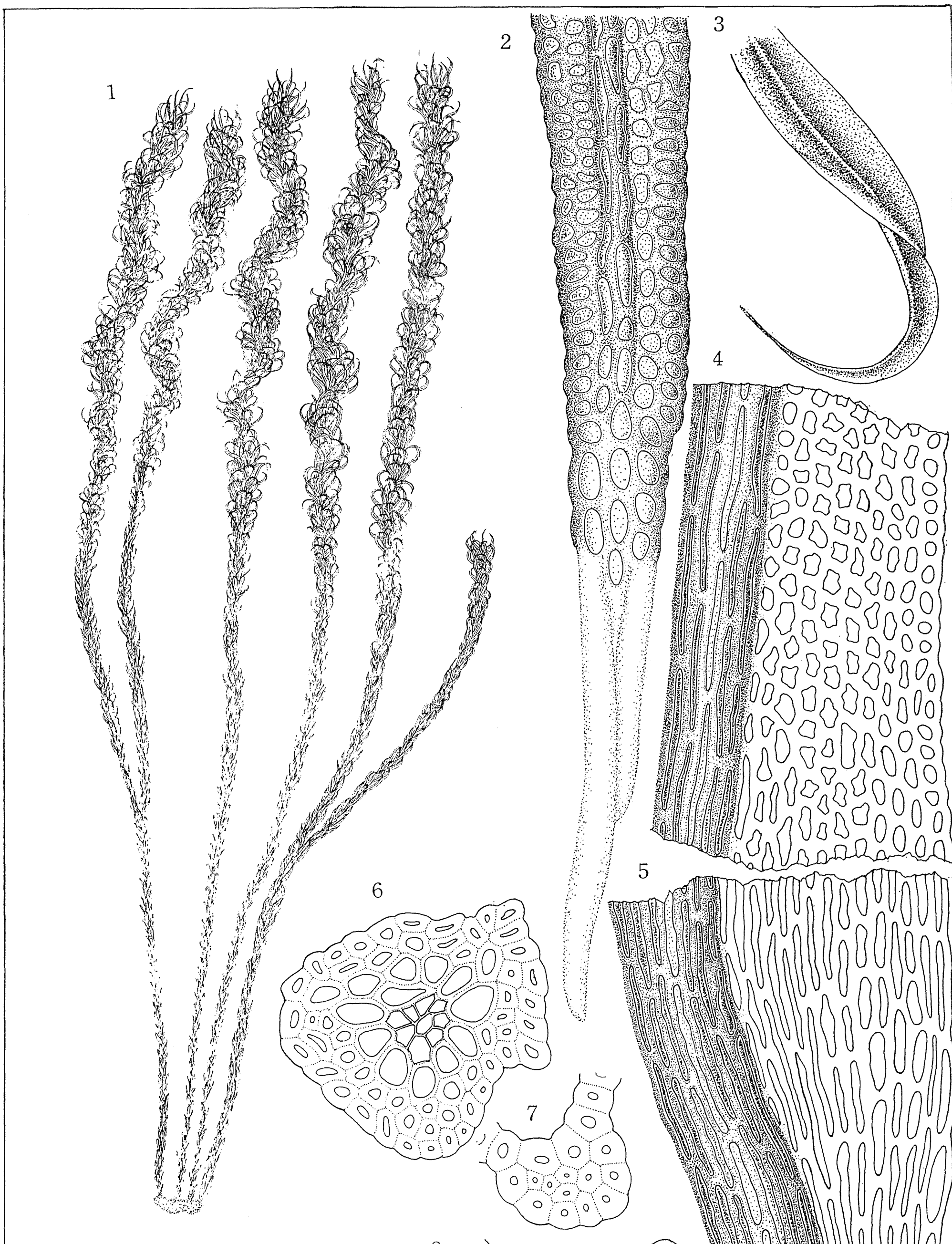
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Plate LX

Gr. brunnescens f. *epilosa* (SCHIFFN.) PAR.

1. cross section of stem $\times 300$
2. and 3. cross sections of leaf margin $\times 450$
4. leaf $\times 36$
5. leaf apex $\times 300$
6. median leaf cells $\times 300$
7. plant habit $\times 3.6$
8. leaf base cells $\times 300$
9. cross section of midrib $\times 450$

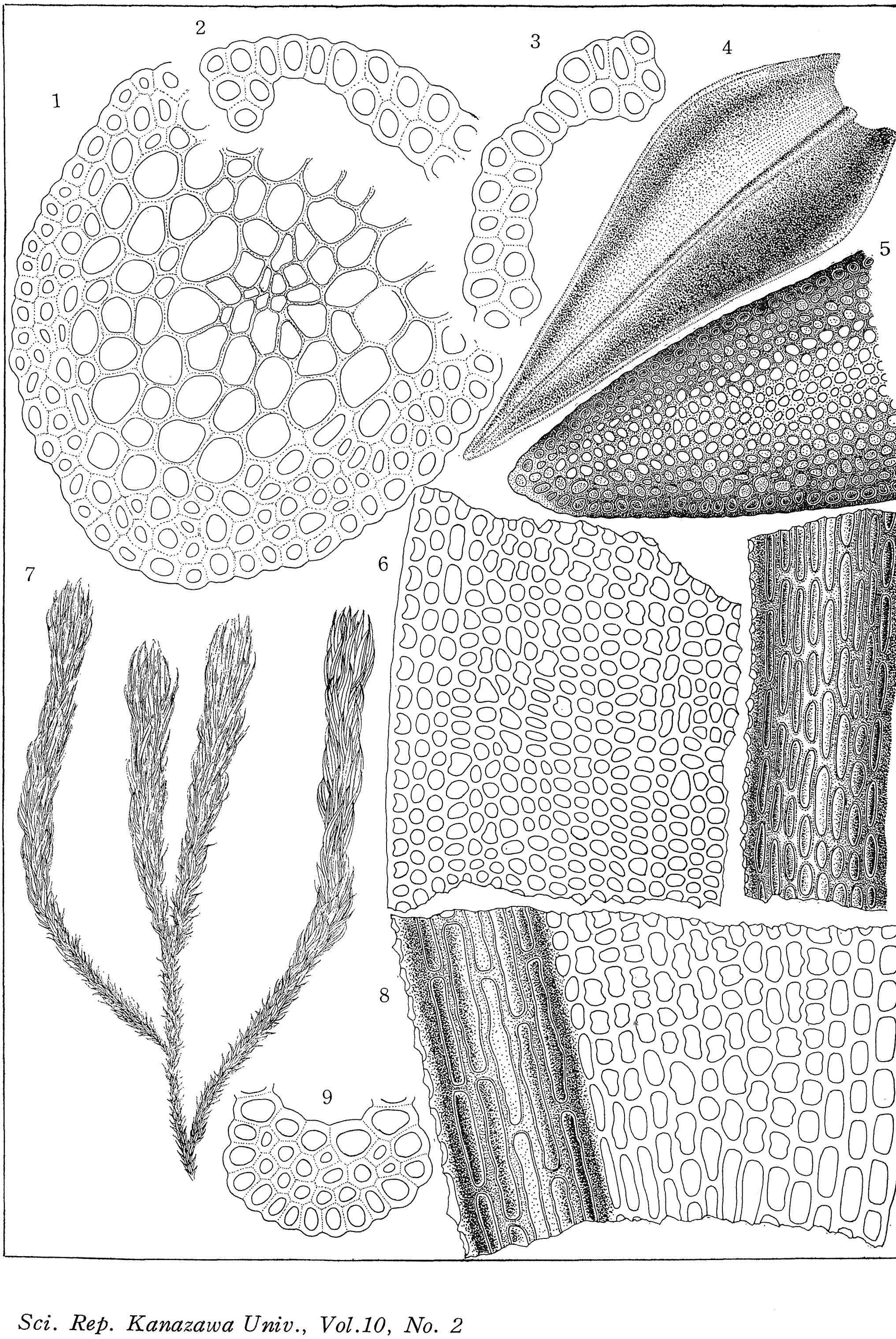
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Plate LXI

Gr. brunnescens f. *humilior* VILHL.

1. cross section of stem $\times 300$
2. leaf $\times 36$
3. leaf apex $\times 300$
4. median leaf cells $\times 300$
5. plant habit $\times 5$
6. leaf base cells $\times 300$

7. 9. 10. and 11. cross sections of leaf margin $\times 450$

8. longitudinal section of midrib $\times 450$

12. cross section of midrib $\times 450$

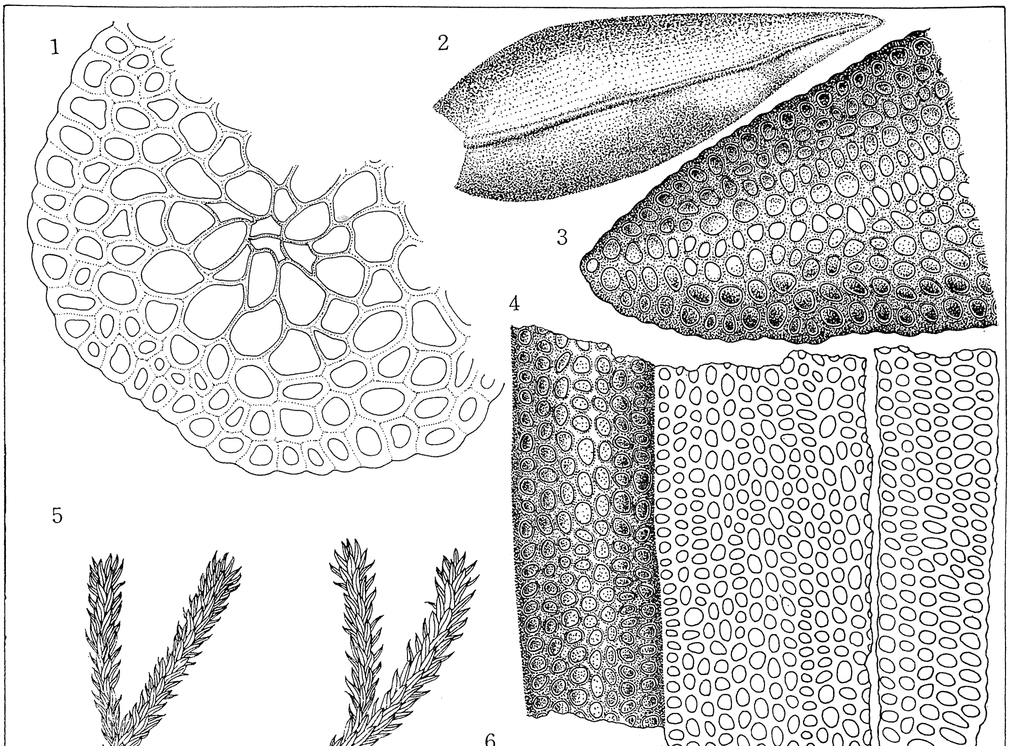
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Plate LXII

Gr. gracilis SCHWAEGR.

1. cross section of stem ×300
2. cross section of midrib ×450
3. 6. and 8. cross sections of leaf margin ×450
4. median leaf cells ×300
5. leaf apex ×300
7. leaf ×36
9. leaf base cells ×300

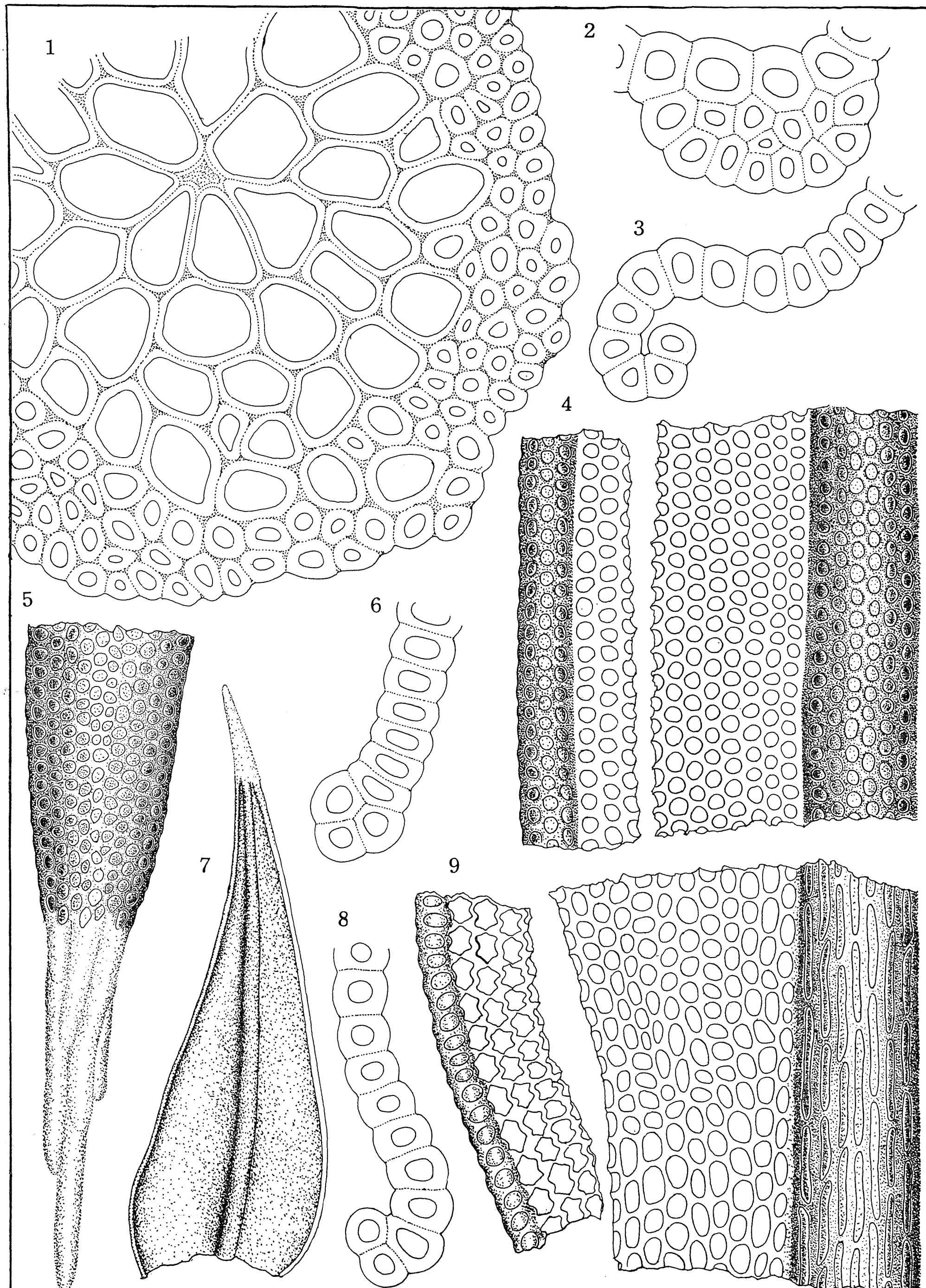
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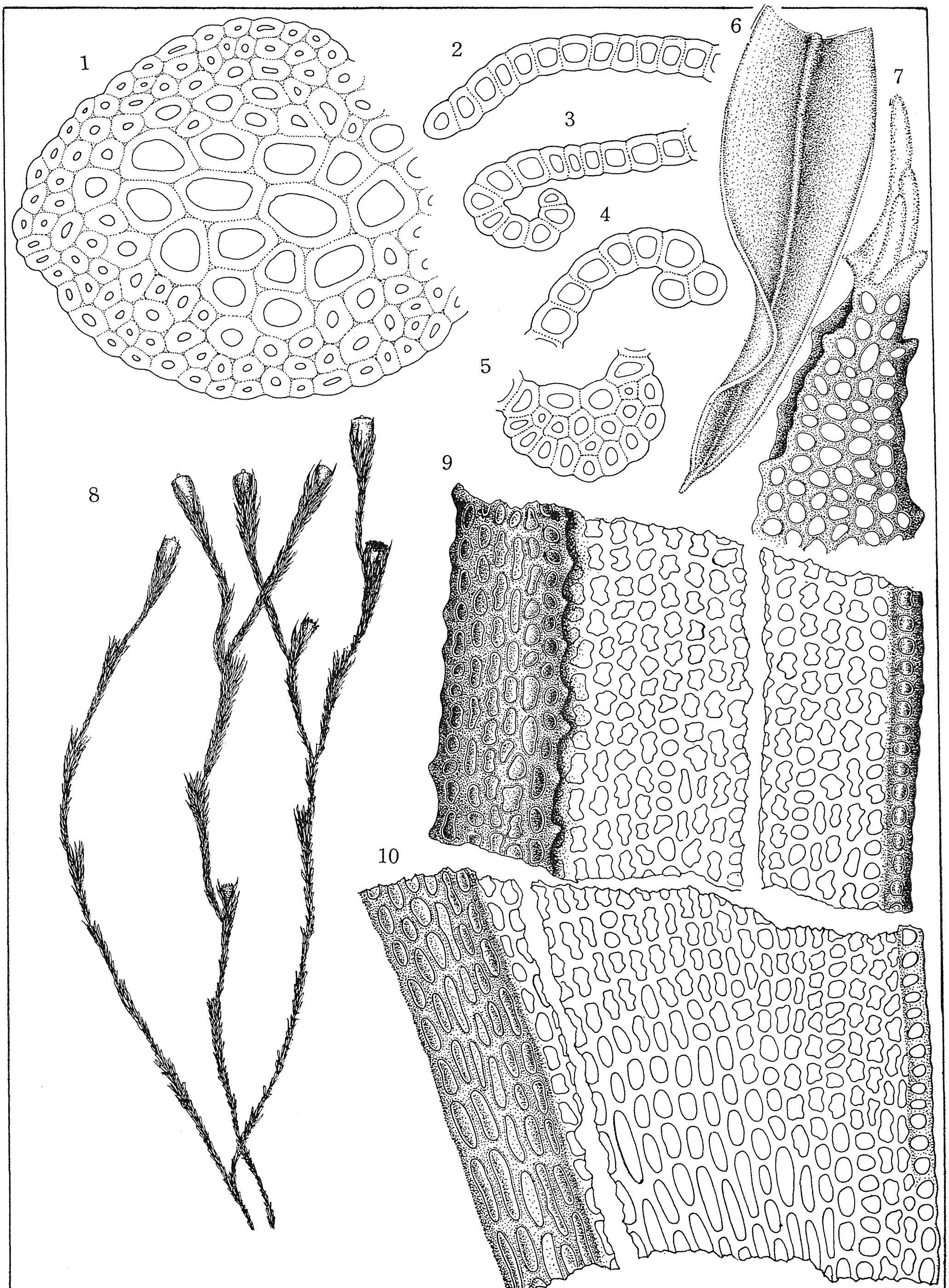
Plate LXIII

Gr. gracilis f. *subepilosa* PILOUS

1. cross section of stem ×300
2. 3. and 4. cross sections of leaf margin ×450
5. cross section of midrib ×450
6. leaf ×36
7. leaf apex ×300
8. plant habit ×5
9. median leaf cells ×300
10. leaf base cells ×300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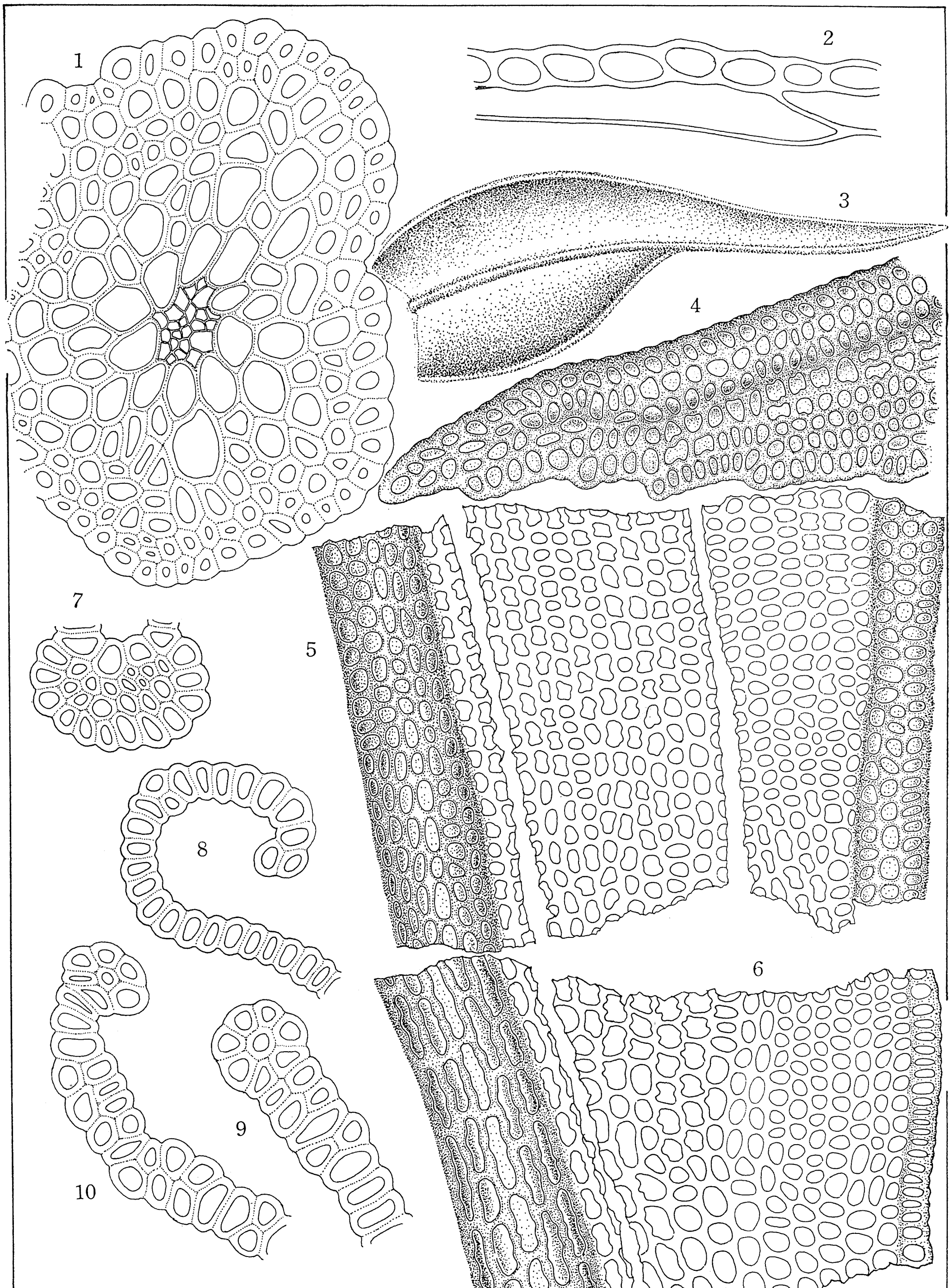
P l a t e LXIV

Gr. gracilis f. *tenuis* VILHL.

1. cross section of stem ×300
2. 8. and 9. cross sections of leaf margin ×450
3. leaf ×36
4. leaf apex ×300
5. median leaf cells ×300
6. leaf base cells ×300
7. cross section of midrib ×450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